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Mass Wasting Processes, Geomorphic Response, and Seasonal Variation of Icy Debris Fans on the La Perouse Glacier and Douglas Glacier, Tai Poutini, Westland National Park, Southern Alps, New Zealand

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MASS WASTING PROCESSES, GEOMORPHIC RESPONSE, AND SEASONAL VARIATION OF ICY DEBRIS FANS ON THE LA PEROUSE GLACIER AND DOUGLAS GLACIER, TAI POUTINI, WESTLAND NATIONAL PARK, SOUTHERN ALPS, NEW ZEALAND

By

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ABSTRACT

Ice-dominated mass wasting processes from deteriorating alpine ice-caps are constructing icy debris fans at outlets of incised bedrock catchments along valley glaciers margins. Previous short-term field observations provided limited understanding of the nature and rate of depositional processes. Recent eight-month time-lapse imagery (January - September 2013) permits the investigation of frequency, area, and volumetric contributions of mass wasting deposits to seven fans in the Southern Alps of New Zealand.

Time-lapse imagery and field observations document remarkably high depositional rates, primarily by ice avalanches (83-98%). Debris flows, slush flows, and rockfalls all account for 2-17% of recorded events. Time-lapse imagery only records major events that emerge onto fans, but direct field observations also document smaller events that occur within the catchments above the fan apex. During nine months, two fans at La Perouse Glacier received 308 major depositional events covering 2675% of the fan's surface areas (ranging from 653 to 2022% per fan). During eight months, five fans at Douglas Glacier received 646 events covering 6151% of the fan's surface areas (ranging from 313 to 2102% per fan). The field observations made at La Perouse recorded seven events on two icy debris fans over two days. At Douglas, field observations recorded 210 events on five fans over two days; more than >90% of these were in the catchments. Frequency of ice avalanches correlates with deposit area, but areas vary significantly. It is not uncommon for five to seven depositional events to cover >50% of a fan area. On especially active days, deposits may cover 80 to >100% of fan surfaces.

For the first time, the evolution processes of icy debris fans has been documented over several seasons, providing information on the dynamics of contributed material to valley glaciers annually. Ice avalanches occurred throughout the observation period, but the pace decreased

during winter. Most depositional events occurred after significant rainfall. However, in warmer months the icecap melting may have been the primary cause of ice avalanches in the absence of rainfall. Debris and slush flows were only mobilized after major rainfall. At both sites, differences in timing, frequency, and depositional process types between fans are attributable to variations in catchment morphology and linkages to the ice/snow supply in the névé regions.

INTRODUCTION

In recent decades climate warming has accelerated mass wasting processes in deglaciating alpine regions. High-level ice caps are deteriorating and exposing major bedrock escarpments from which is chiefly ice-dominated, mass wasting processes such as ice avalanches, rockfalls, icy debris flows, and slush flows, are channeled through incised bedrock catchments and discharged onto the margins of valley glaciers constructing triangular landforms known as icy debris fans (Kochel and Trop 2012). Figure 1 is a schematic cross section that shows the general evolution icy debris fans during deglaciation. The frequency, magnitude, and overall volumetric contribution of mass wasting processes onto icy debris fans and subsequently to the underlying glaciers through icy debris fans are poorly understood and under-described beyond pilot studies by Kochel and Trop (2008, 2012).

Icy debris fans are formed by erosional and depositional processes that are part of an early paraglacial landscape evolution. Major works done by Ryder and Church (1972) and Ballantyne (1999) have described many paraglacial mass-wasting processes in deglaciating alpine regions. Paraglacial is the time period, or interval, immediately following deglaciation, characterized by extremely rapid mass wasting processes and high sedimentation rates, where glaciers retreat from an area, removing support for the over steepened rock slopes (Benn and Evans, 2010). Paraglacial is distinct from periglacial, which defines geomorphic processes that occur in cold environments with mean annual temperatures below 0°C (Church and Ryder, 1972). Observations made by Kochel and Trop (2012) indicate that the evolutionary cycle of icy debris fans occur during the early stages of the paraglacial period.

This project explores three icy debris fans located on the La Perouse Glacier and five icy debris fans on the Douglas Glacier in the Southern Alps, South Island, New Zealand (Figure 2) and has four objectives, including: 1) investigation of the magnitude and frequency of depositional events across various seasons, 2) determination of the dominant depositional processes, 3) determination of the areas and volumes of depositional events and icy debris fans, and 4) documentation of the amount of rock/ice that icy debris fans contribute to valley glaciers. These objectives are achieved through an integrated dataset of time-lapse photographs, ground-based laser scanning, and direct field observations.

The South Island valley glaciers located in New Zealand (Figure 2a.) are very responsive to climate change (Kaplan, et al. 2010) and have started experiencing mass-wasting processes, at an early paraglacial interval. Over the past decade many of the >3,100 glaciers in New Zealand have reacted to global warming (Chinn, 1989; Fitzsimons and Veit, 2001), and have begun to retreat. However, New Zealand valley glaciers have constantly been changing with variations of climate; reflecting the annual balance of inputs of snow, ice, and lithic material, and ablation (melting/sublimation) of ice and snow. The input and loss of material can be set up in the mass balance equation, which is an important link in understanding the past and predicting the future of global climatic changes (Benn and Evans, 2010). Additionally, in recent decades the climate warming of alpine glaciated regions in New Zealand has likely decoupled some valley glaciers that were once linked to upper-level icecaps by large icefalls exposing major bedrock escarpments, characterized by accelerating mass-wasting processes. Documenting the volumetric contribution of mass-wasting material added to the valley glaciers via icy debris fans will help understand the mass balance of the glacier through this time of climate change.

The New Zealand alpine glaciated regions are in a tectonically active region (Figure 2, Alpine Fault highlighted in yellow). The two sites under investigation are La Perouse Glacier (Figure 3) and Douglas Glacier (Figure 4) South Island, New Zealand, Westland National Park (Figure 2b.). This paper further explores icy debris fans located at La Perouse Glacier and Douglas Glacier, investigating the geomorphic and seasonal variations of icy debris fans and focuses on understanding the relationship between icy debris fans and the underlying valley glacier. In doing so, this study provides an assessment the formative processes and seasonal evolution of these poorly understood landforms.

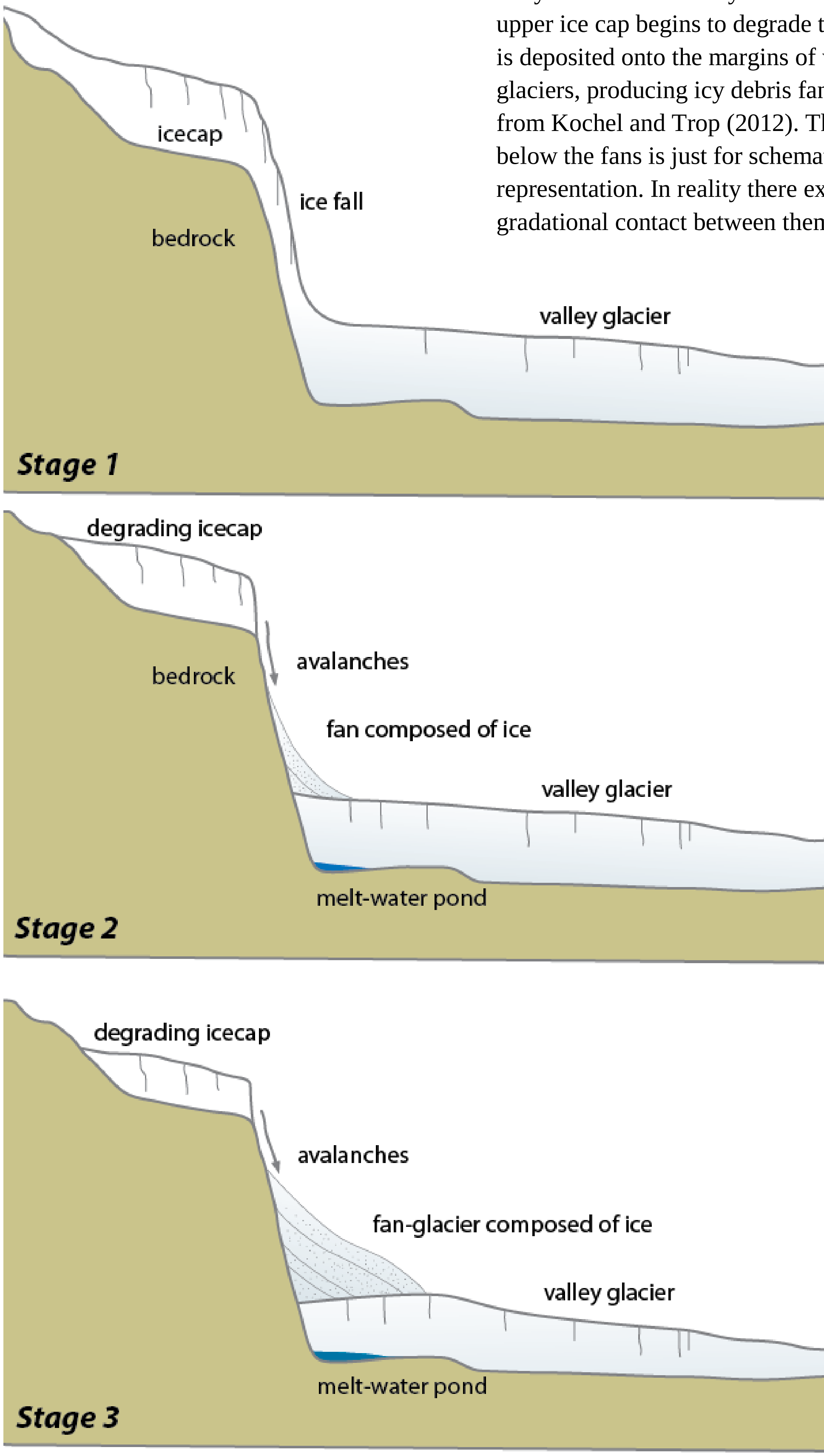


Figure 1. Schematic model depicting the early evolution of an icy debris fan. As the upper ice cap begins to degrade the material is deposited onto the margins of valley glaciers, producing icy debris fan. Adapted from Kochel and Trop (2012). The line below the fans is just for schematic representation. In reality there exists a gradational contact between them.

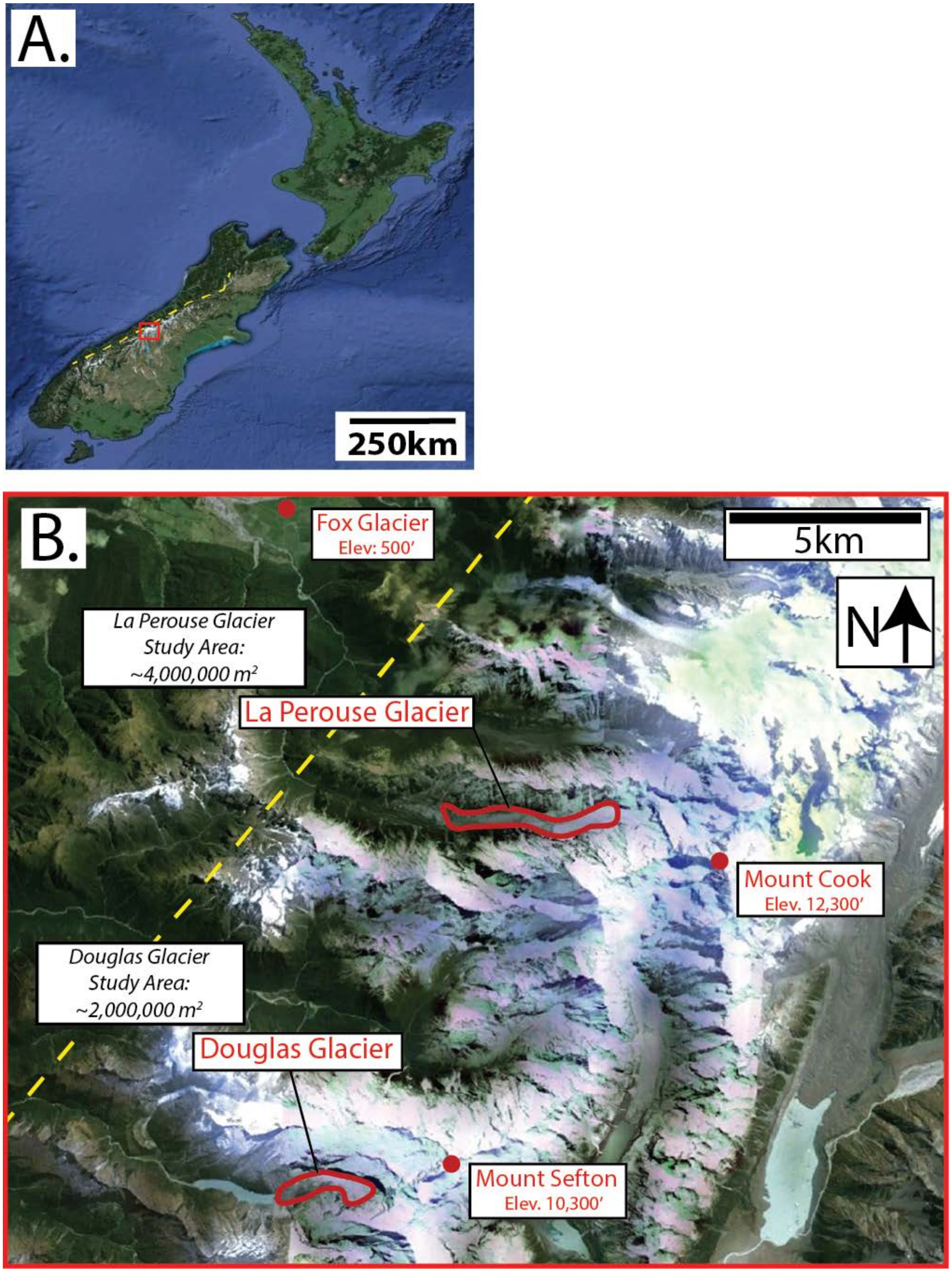


Figure 2. A) Index map of Southern New Zealand, red rectangle indicates study location in the Westland National Park. B) Location of two study sites, La Perouse, with an area of ~4,000,000m^2, and Douglas Glacier, area of ~2,000,000m^2. The yellow dashed line indicates the position of the Alpine Fault.

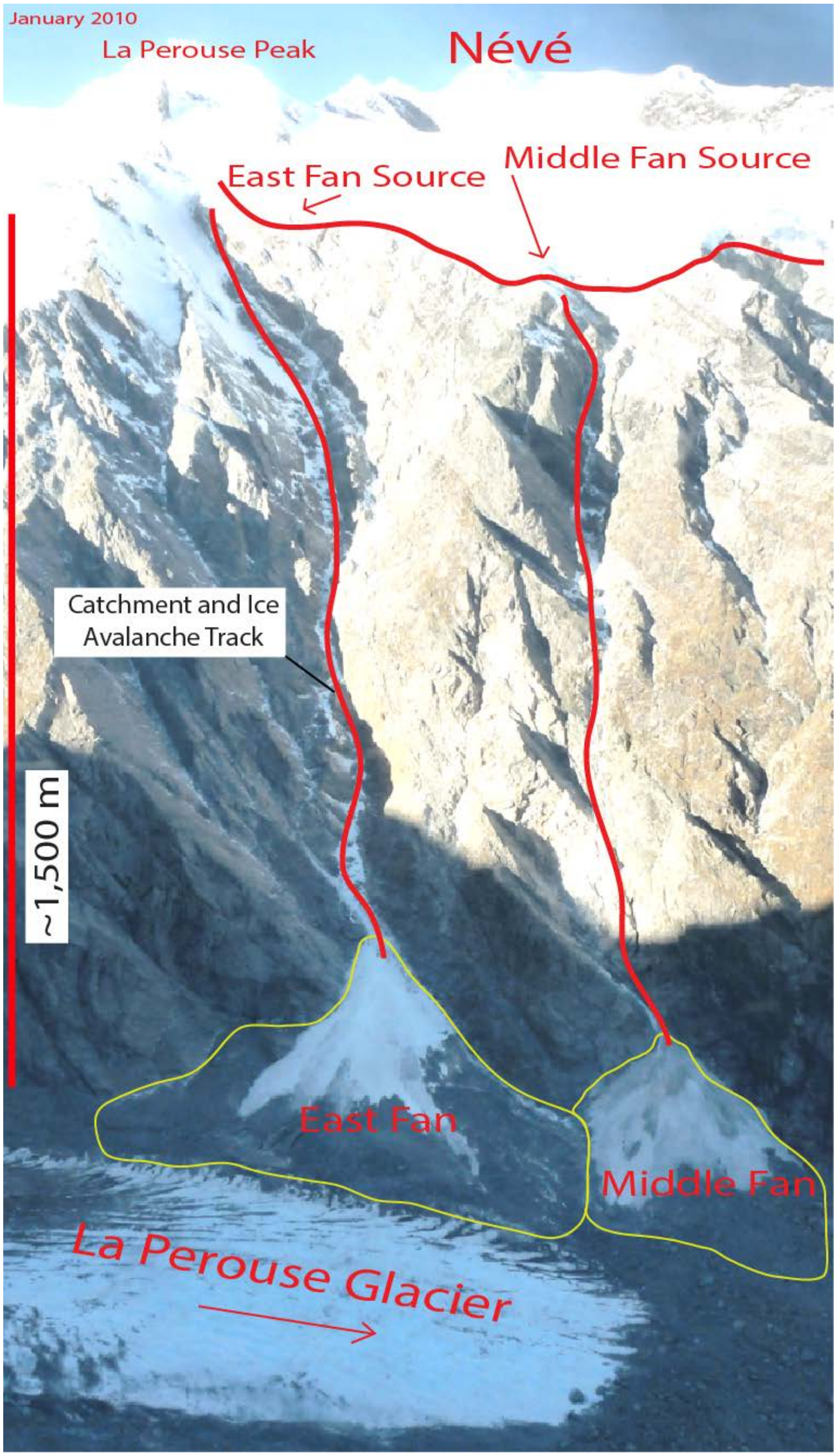


Figure 3. La Perouse study site show two icy debris fans, Middle and East, fans. The upper ice cap is above the fans, and the fans are along the margins of the valley glacier. Note, there are other fans located along La Perouse Glacier not shown in this photograph.

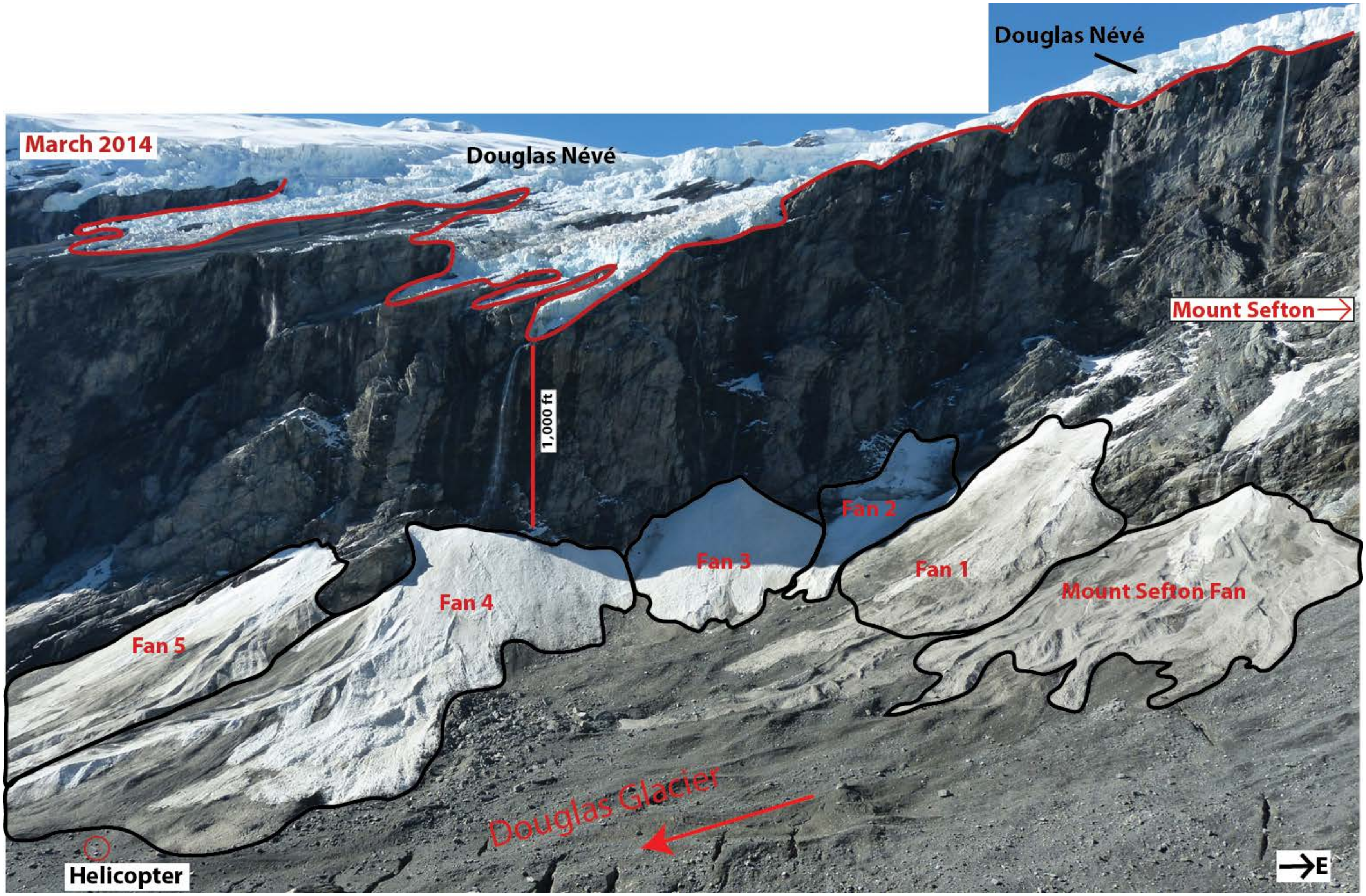


Figure 4. Douglas Glacier study site, with six fans, five sourced from the Douglas Névé ice cap and one sourced from nearby Mount Sefton, located East of this site. The black lines mark the transition between the distal margin of the fans and the underlying Douglas Glacier. Notice a helicopter for scale in the lower left corner. Note, there are other fans located along La Perouse Glacier not shown in this picture.

METHODS

Fieldwork

Three icy debris fans at La Perouse Glacier, and five icy debris fans at Douglas Glacier were mapped and measured in the field between March 9-16, 2014. Several major mass wasting deposits, mostly ice avalanche deposits, were measured (Figure 5) and mapped (Figures 6-8) onto base map images that were collected during previous field studies in January 2013. The importance of collecting measurements in the field was to provide a scale to calibrate time-lapse imagery (spanning 8-9 months) and to estimate average deposit thickness used later to calculate the deposit volume.

Figure 6 illustrates the mass wasting deposits that were recorded on the Middle Fan at La Perouse Glacier during the field survey in March 2014. Measurements of thickness, width, and length were made using a hand held laser range finder (Figure 5). The colors in Figure 6 represent different deposits. New deposits overlie the older deposits. Younger deposits have a higher albedo, while older deposits are darker due to ablation. As ablation proceeds, ice melts

Table 1. Field measurements made of the Middle and East Fan at La Perouse Glacier in 2014.

Field Measurements at La Perouse Glacier	Middle Fan	East Fan
Number of Ice Avalanches	13	8
Thickness of Deposit	1.8-2.5 m	2.0 m
Width of Deposit	15-33 m	23-64 m
Length of Deposit	222 m	---

and darker lithic materials are concentrated. Similarly, Figure 8a illustrates all of the ice avalanches deposited at Douglas Glacier and mapped in the field in March 2014. Field measurements made at La Perouse Glacier can be found in Table 1, and field measurements made at Douglas Glacier can be found in table 2.

Table 2. Field measurements made of Fan 3, 4 and 5 at Douglas Glacier in 2014.

Field Measurements at Douglas Glacier	Fan 3	Fan 4	Fan 5
Number of Ice Avalanches	3	5	4
Thickness of Deposit	0.6-3 m	2.2 m	0.8-2.0 m
Width of Deposit	---	13-49 m	49 m
Length of Deposit	171 m	99-310 m	203-233 m

Time-lapse Imagery

For the first time ever, long-term observations were recorded on icy debris fans using time-lapse cameras. The time-lapse camera at La Perouse Glacier recorded nine months of time-lapse imagery (January-September 2013), and eight months for the Douglas Glacier (January-August 2013). The time-lapse cameras did not run for the complete year-long time period envisioned, due to the consistently changing and harsh environment. Additionally, the number of time-lapse cameras that could be deployed was limited to the lack of stable and accessible installation locations with direct lines of sight.

Three time-lapse cameras were installed at La Perouse Glacier. Figure 8 illustrates the areas in which the cameras were deployed. The cameras are labeled, with the closest camera being LP1 (310 m from the apex of the Middle Fan), middle camera LP2 (330 m from the apex of the Middle Fan), and the farthest camera LP3 (830 m from the apex of the Middle Fan) at La Perouse Glacier. Both cameras LP1 and LP2 were positioned on >5m long boulders that were debris from a rockfall that partly covered the glacier. Therefore, LP1 and LP2 were not stationary cameras, but moved with the flow of the glacier. Camera LP3 was anchored in bedrock on the opposite side of the valley from the icy debris fans. Camera LP3 was focused on the Middle Fan and East Fan (Figure 9b.). The imagery recorded from LP3 was used for the analyses of the Middle Fan and East Fan at La Perouse Glacier, which are the data used throughout this document. Camera LP3 was used due it's the longevity and the image capturing the entirety of both the Middle Fan and East Fan. Cameras LP1 (Figure 9c.) and LP2 (Figure 9d.) will be analyzed in future studies. The endurance of camera LP3 was from 12 January 2013 to 13 September 2013, where camera LP1 lasted from 8 January 2013 to 28 August 2013 and LP2 from 8 January 2013 to 14 June 2013.

Two cameras were installed at Douglas Glacier (Figure 10a.). Both cameras were installed on bedrock across the valley from the icy debris fans, approximately 800 m from the apex of Fan 4. The cameras are labeled D1 (Figure 10b.), recording from 7 January 2013 to 9 January 2013, and D2, recording from 7 January 2013 to 22 August 2013. The images recorded from D2 were used to analyze Fans 1, 2, 3, 4, 5, as well as the distal deposits from Mount Sefton (Figure 10c.). D2 was used due to its longevity of images, adding more observational data.

Camera LP3 took two photographs each day, and camera D2 took one photograph each day. The photographs were analyzed by mapping the outlines of deposits that occurred each day. The deposits outlined were large deposits that were seen from the position of the camera. Small deposits were likely not included in this analysis. Therefore the calculations made from the time-lapse imagery dataset underestimate the area of deposits because smaller events, shown to be frequent within the catchment from field observations cannot be seen in the time-lapse imagery. Additionally, the precise outline of events is difficult to determine, hence a minimum area was used in mapping.

Deposits mapped in time-lapse images were digitized in Adobe Illustrator CS6 to quantify their areas. Calibration of scales in these images was done by using deposits measured directly in the field (Tables 1-2 and Figures 6-8) and by using Terrestrial Laser Scanner (TLS) is based on Light Distance and Ranging (LiDAR) (surveyed in the field in January 2013). TLS-LiDAR was used to accurately measure bedrock features visible in both the time-lapse cameras and LiDAR surveys.

Terrestrial Laser Scanner/Light Distance and Ranging and Area and Volume Estimation

The TLS-LiDAR , and is also referred to as ground-based LiDAR. TLS/LiDAR data was collected by UNAVCO during the January 2013 at La Perouse and Douglas Glaciers. TLS/LiDAR was positioned at a distance of less than 200 m around the base of the icy debris fans. The total precision of the TLS data was on the order of 8 cm. Surveys were made at La Perouse and Douglas Glaciers, collecting full data for all the icy debris fans mentioned in this document.

TLS is a method that produces high-resolution three-dimensional maps and images. In a 3-D view the instrument scans the landscape and selects points on the surface and measures the distance, horizontal, and vertical angles to the point (Geospatial Engineering Practices

Committee, 2014). These measurements give a position to the point in space. GPS measurements are also incorporated, providing an accurate geo-referencing. The initial TLS position was geo-referenced using RTK-GPS, and used PositioNZ stations in New Zealand for centimeter accuracy (Kochel et al., 2013). Points are selected to create a pointcloud, which is a product of the TLS. TLS images the surface using multiple scales for precision (Geospatial Engineering Practices Committee, 2014).

Furthermore, the use of TLS/LiDAR helped create a scale for the 2-D time-lapse photographs. TLS/LiDAR documented significant bedrock features, foliation and weathering. Figure 11 shows two TLS scans from Fan 4 at Douglas Glacier and the Middle Fan at La Perouse Glacier. The red outlines Fan 4 and records a measurement from a bedrock structural feature (purple bar in Figure 11) measuring 68.7 m. Figure 11, also outlines a recent ice avalanche deposit on the Middle Fan at La Perouse outlined in blue, and the red line outlines the entirety of the Middle Fan, with a measured bedrock feature (purple bar in Figure 11) of 40.3 m. The recent ice avalanche deposit is black, due to the poor reflection of ice and snow material.

Bedrocl structural features measured in the TLS/LiDAR software, RiSCAN, were recorded and converted back to Adobe Illustrator. For example, Figure 11 demonstrates the process used: 1) a bedrock feature noticeable in the time-lapse imagery and LiDAR is selected, 2) this feature is measured in both RiSCAN and Adobe Illustrator (each software will produce two different measurements; RiSCAN will be the actual measurement), and 3) the Adobe Illustrator measurement is converted to the actual measurement made in RiSCAN.

$$\frac{Adobe\ Measurement\ of\ Bedrock\ Feature}{RiSCAN\ Measurement\ (Actual) of\ Bedrock\ Feature}$$
$$= \frac{Adobe\ Measurement\ of\ an\ Outlined\ Area}{Actual\ Measurement\ of\ the\ Outlined\ Area}$$

How to find the actual area of the left side (red), based off measurements seen in Figure 12:

$$\frac{0.00013m^2}{1600m^2} = \frac{0.00094m^2}{11{,}570m^2}$$

How to find the actual area of the right side (blue), based off measurements seen in Figure 12:

$$\frac{.000064m^2}{400m^2} = \frac{0.001157m^2}{7{,}230m^2}$$

For the Middle Fan at La Perouse Glacier two bedrock structures were measured, a left (red in Figure 11) and a right (blue in Figure 12), and converted to the actual, RiSCAN, measurement. The left and right actual measurements were combined to find the entire scale of the Middle Fan. Additionally, the Middle Fan as a whole was used to estimates the actual scale for the East Fan. Deposit volumes were estimated by multiplying area by 2.0 m, which was the average thickness of ice avalanche deposits measured in the field.

Figure 5. Measurements of length, width, and thickness of mass wasting deposits were made using a hand held Laser Range Finder in March 2014. Note the variable color of ice avalanche deposits. The recently deposited light-colored ice avalanche deposits overlie darker colored, older deposits, as can be seen by the yellow outline.

Figure 6. Depositional events mapped on the Middle Fan at La Perouse Glacier in March 2014. The fan measurements, using a hand-held laser range finder, have been denoted. Each color represents the minimum area of different ice avalanche deposit, due to the overlapping of younger deposits on top of older. White bars indicate thicknesses, and black lines are length/width measurements.

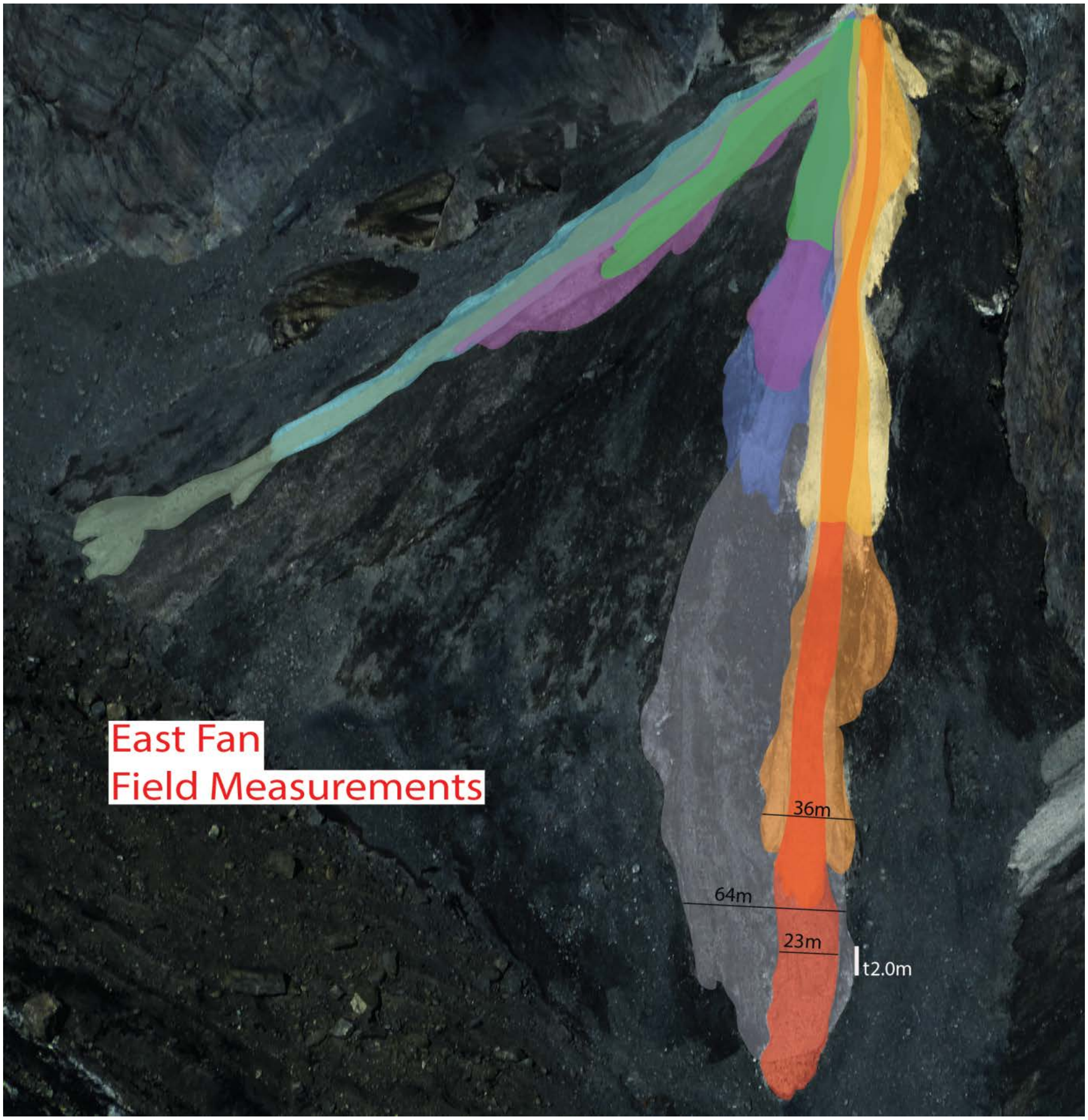


Figure 7. Depositional events mapped on the East Fan at La Perouse Glacier in March 2014. The fan measurements, using a hand-held laser range finder, have been denoted. Each color represents the minimum area of a different ice avalanche deposit, due to the overlapping of younger deposits on top of older. White bars indicate thicknesses, and black lines are length/width measurements.

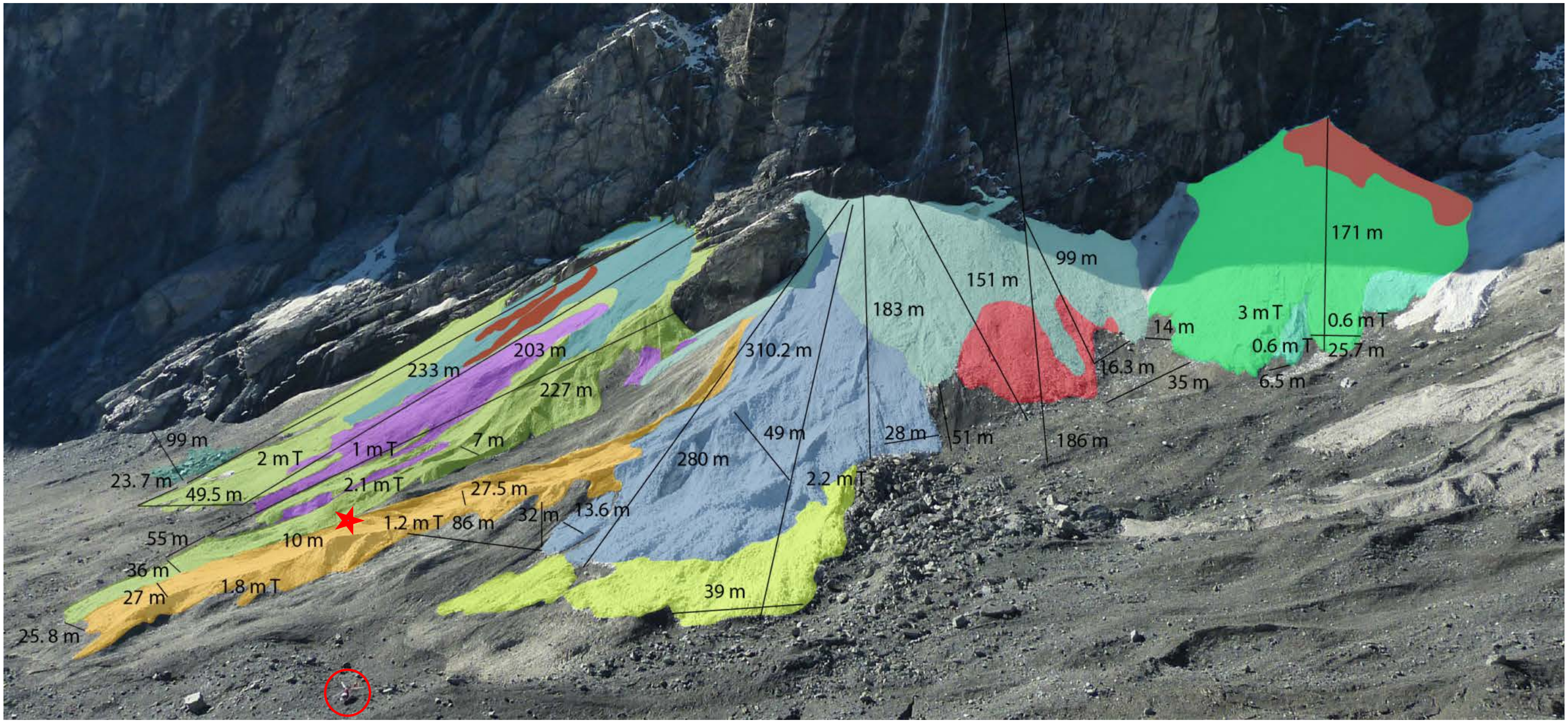


Figure 8. Depositional events mapped on Fans 3, 4, and 5 at Douglas Glacier, in March 2014. The fan measurements, using a hand held Laser Range Finder, taken in the field have been denoted. Each color represents the minimum area of different ice avalanche deposit, due to the overlapping of younger deposits on top of older. Note helicopter circled in red, and the red star indicating an ice avalanche deposit smoothing the surface.

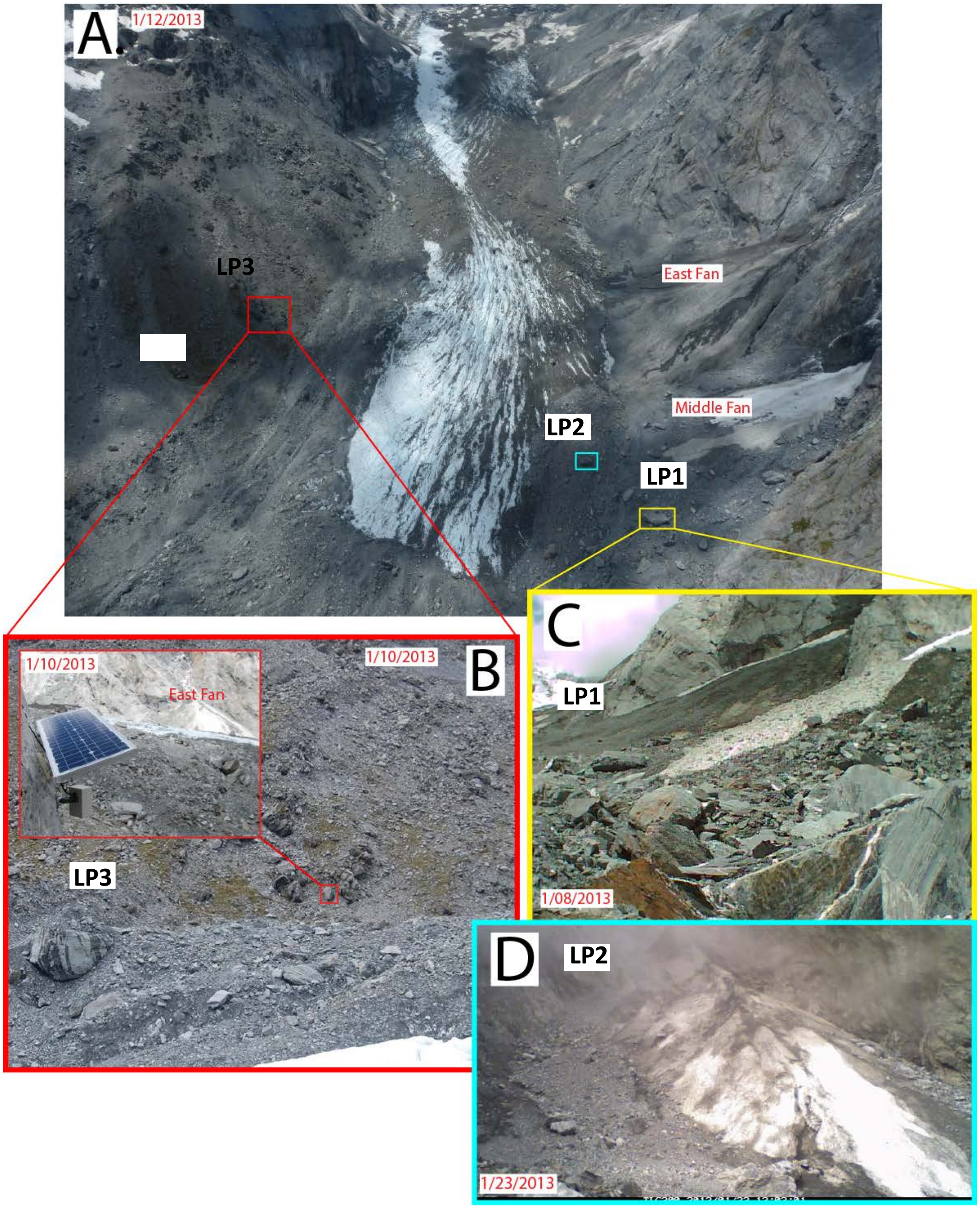


Figure 9. A) Location of where the three time-lapse cameras were installed in 2013 labeled LP1, LP2, LP3. Camera LP1 recorded images from 8 January 2013 to 28 August 2013 and LP2 from 8 January 2013 to 14 June 2013, and LP3 from 12 January 2013 to 13 September 2013. B) The stationary position of LP3, with a view on the Middle Fan and East Fan at La Perouse Glacier. Time-lapse imagery from this camera was used to analyze the data, due to the life time duration. Imagery from LP1

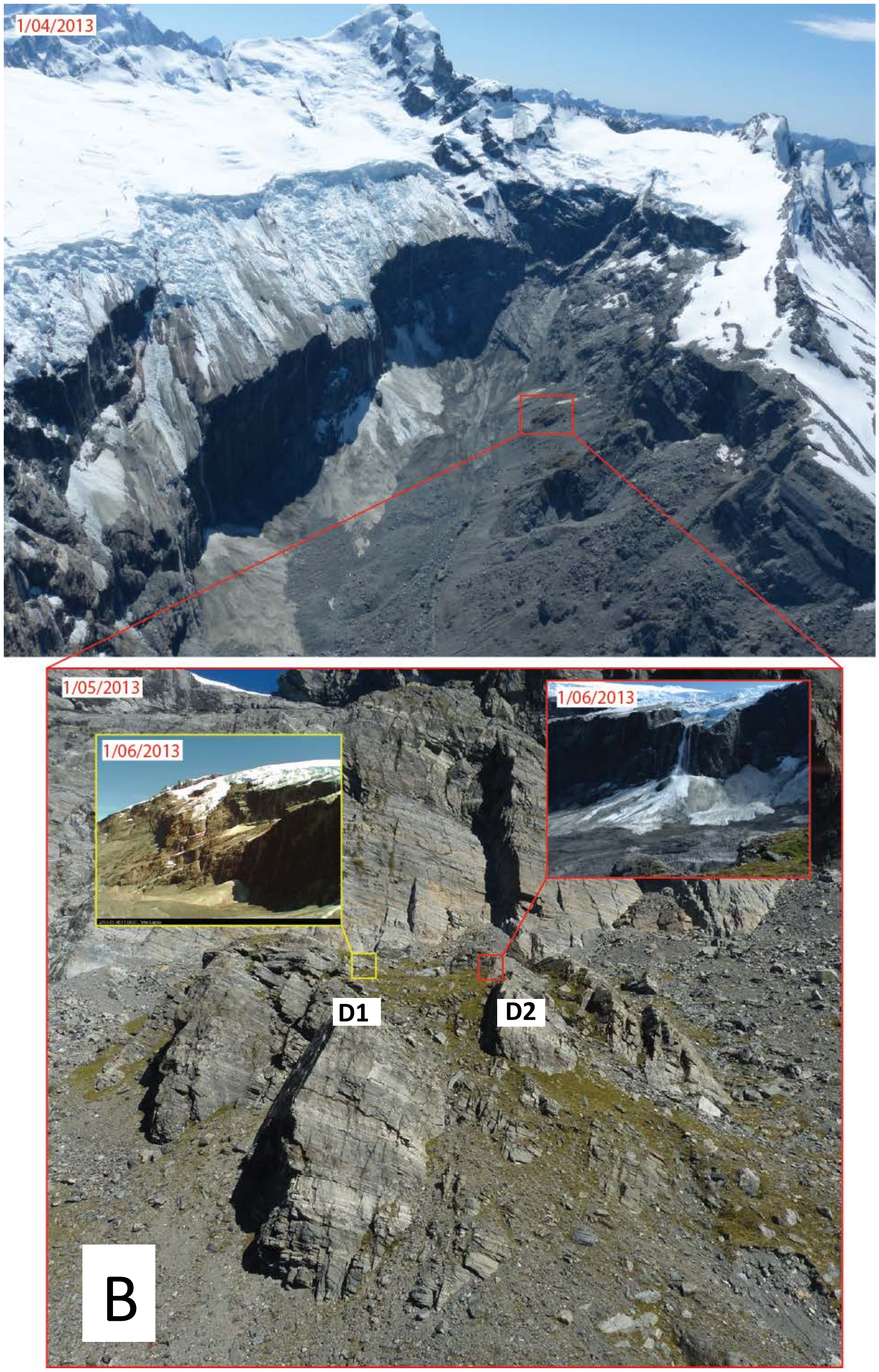


Figure 10. A) Location of where the two time-lapse cameras were installed in 2013 labeled D1 and D2. Camera D1 recorded images from 7 January 2013 to 22 August 2013, and D2 from 7 January 2013 to 9 January 2013B) A closer image of the positions for both D1 and D2 with a view on Fan 2, 3, 4, 5, and incomplete Mount Sefton deposits at Douglas Glacier. Time-lapse imagery from camera D2 was used to analyze the data, due to the life time duration.

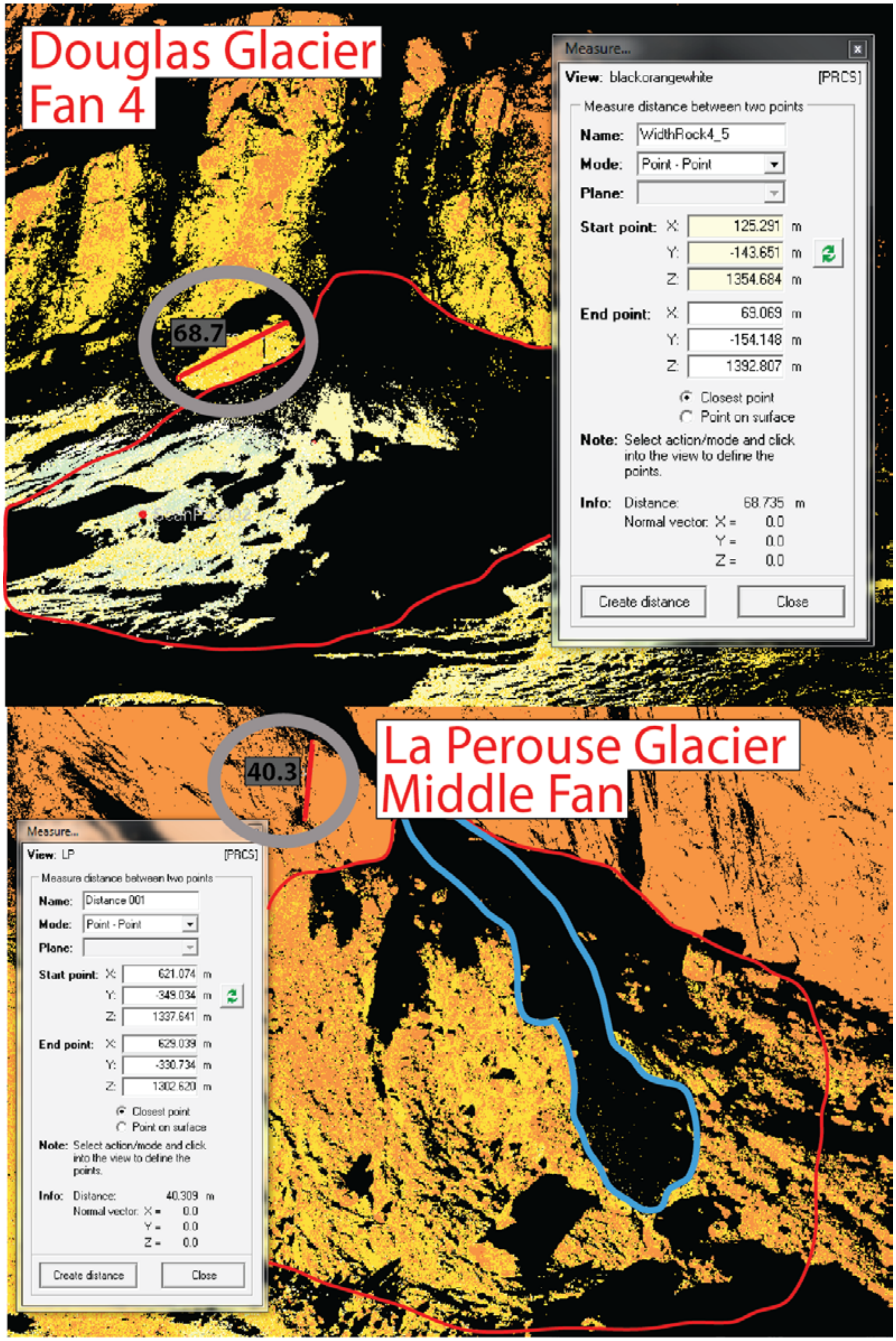


Figure 11. TLS scans with the red outlining icy debris fans, Fan 4 at Douglas Glacier and the Middle Fan at La Perouse, and blue is outlining an ice avalanche deposit. TLS surveys were used to create scales for the time-lapse imagery, by measuring noticeable bedrock features in meters (purple bars) that can be seen in TLS, and the time-lapse, note the gray circle.

Figure 12. Bedrock features visible in time-lapse images and TLS/LiDAR were measured using TLS/LiDAR to create a scale in Adobe Illustrator, for La Perouse study site. Scales are bedrock features (40m and 20m) shown by red and blue bars. These scales were used to measure the left and right parts of the fans which are outlined in red and blue, corresponding with their scales. The red scale was used to calculate an area of 11,570 m^2, and the blue scale to calculate and area of 7,230 m^2.

GEOMORPHOLOGY OF ICY DEBRIS FANS

Catchments and Depositional Processes on Icy Debris Fans

La Perouse Glacier is located 9-15 km east of the Alpine Fault and Douglas Glacier is located 18-21 km east of the Alpine Fault (Figure 2). The bedrock in these areas is mainly comprised of a “semi-schistose” greywacke and argillite that transition into well-foliated schist towards the west along the fault zone (Cox and Findlay, 1995). At both La Perouse and Douglas Glacier, the bedrock is steeply foliated schist. The degrading ice and lithic from the upper icecap is channeled to the apex of icy debris fans through incised bedrock catchments, which typically start small and become progressively larger over time (Kochel and Trop, 2012). Catchments typically evolve along bedrock joints or foliation planes (Kochel and Trop, 2012). At La Perouse and Douglas Glacier, the catchments are incised into steeply dipping metamorphic rocks parallel to foliation. The catchments dip in the same direction as the dip of bedrock foliation planes, thus enhancing mass wasting processes. Icy debris fans located at La Perouse Glacier and Douglas Glacier have different incised catchments (Figure 13). Catchments at La Perouse Glacier are well developed, narrow, follow the steeply dipping foliation, and are similar to a canyon structure (Kochel and Trop, 2012). The incised catchments at Douglas are very weakly developed notches incised into the bedrock along the foliation. Unlike alluvial fans, there is no relationship between the catchment area and fan area for icy debris fans (Kochel and Trop, 2012). Fan size reflects the volume of ice and lithic material contributed by the catchment but the source is combination of wasting icecaps and secondarily winter snowfall, thus, catchment size becomes less relevant compared to fans constructed from water flood and debris flow events in non-glaciated areas. Catchments lengths vary from 306 m to 1,416 m, catchment gradients range from 50° to 70°, and catchment relief ranges from 551 m to 1,551 m (modified from Kochel and Trop, 2012).

Four major depositional processes deliver poorly sorted icy and clastic material from

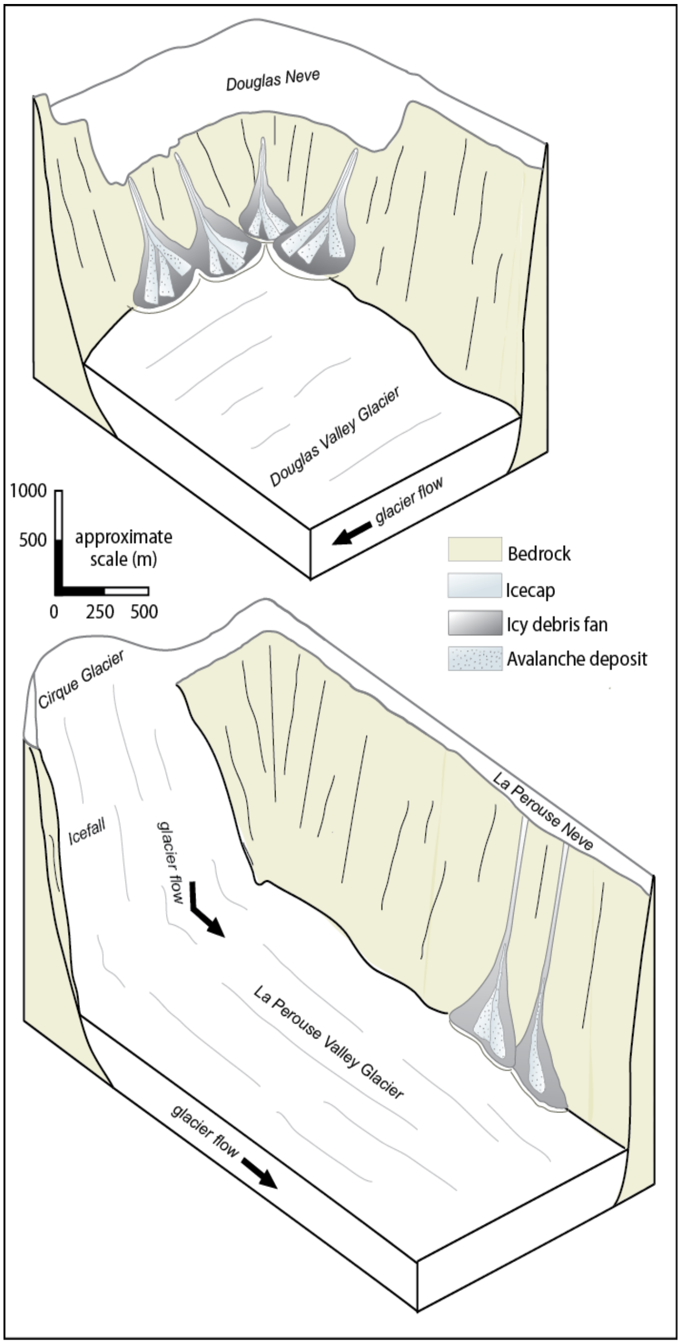


Figure 13. Icy debris fans are developed at the base of catchments. Douglas and La Perouse Glaciers have different connections between the upper-level icecap and the icy debris fans. The Douglas site has small incised notches in the bedrock, where the incised bedrock canyons at the La Perouse site are 800-1,300 m long. Modified from Kochel and Trop (2012). Note the direct connection to up-valley glacier at La Perouse Glacier.

high-level icecaps to icy debris fans are ice avalanches, icy debris flows, slushflows, and rockfalls (Figure 14). These depositional processes are channeled through incised bedrock, through catchments, and eventually onto icy debris fans, located on the margins of valley glaciers. Ice clasts travel as avalanches through the incised bedrock, and become more rounded, and typically transform into a distinct grainflow they emerge through the apex onto the fan (Kochel and Trop 2012; van der Woerd et al., 2004).

The most common depositional process is ice avalanche. Ice avalanches are comprised of boulder to cobble-sized ice clasts with minor boulder to cobble-sized lithic clasts Their deposits can be distinguished by straight fronts. Ice avalanches occur when ice breaks off of the upper-level icecap. The icy mass travels down gradient, breaking into smaller ice clasts. The ice clasts reduce in size and become rounded due to the collision of other ice clasts and bedrock (Alean, 1985; Kochel and Trop, 2012). The maximum size of an ice avalanche deposit measured in the field had a length of 310 m and a width of 70 m (measurement was collected from Douglas Glacier in Figure 7). Smaller ice avalanche deposits rest on top of older, larger deposits Figure 14) (Alean, 1985). Additionally, noted by Alean, the first ice avalanche deposits more or less fill crevasses and smooth out the surface of previous ice deposits (Figure 7).

Icy debris flows are mass movements that consist of highly saturated ice and lithic debris (Kochel and Trop, 2012). The deposits are lobate with developed levees on each side of the deposit which continue down to the frontal lobe (Rapp, 1986; Kochel and Trop, 2012). Icy debris flows are triggered by extreme rainfall or a positive increase in temperature (Rapp, 1986, Addison, 1987). Icy debris flows are rich with poorly-sorted angular clastic sediments, but also contain ice clasts (Kochel and Trop 2008, 2012). The sediments vary from boulder to gravel-size ice clasts, suspended in a sandy to mud matrix. Debris flows require the mix of cohesionless material and precipitation to mobilize the debris (Brunsden, 1979; Innes, 1983; Decaulen, 2006).

Icy debris flows are common only in catchments large enough to temporarily store rockfall and ice avalanche deposits from earlier events where they can be mixed with melt water from the icecaps or rainfall

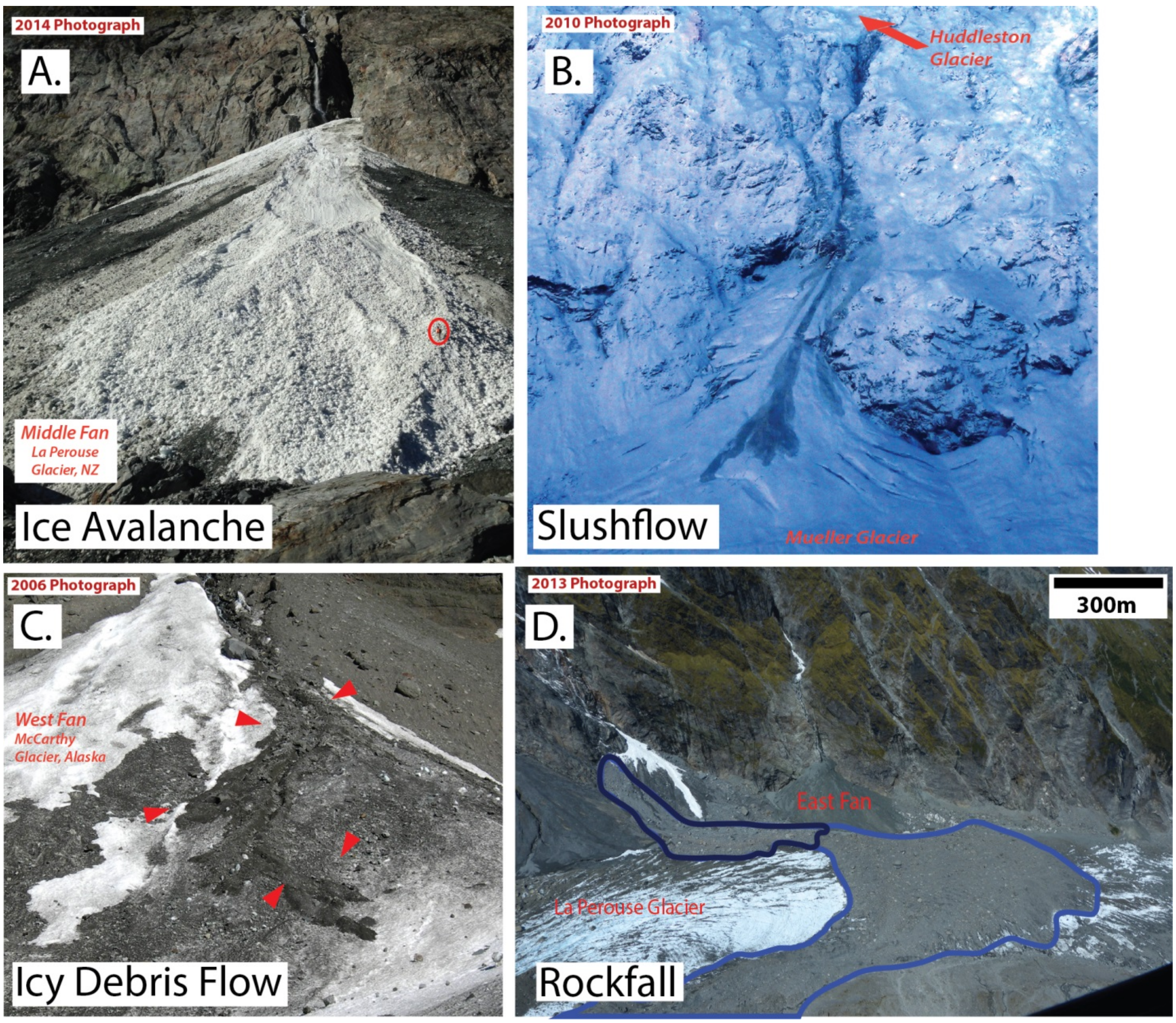


Figure 14. There are four different types of depositional processes that bring both ice and lithic material to icy debris fans. The red circle in A. highlights a person for scale. The red triangles in C. are pointing to the icy debris flow deposit. The blue in D. outlines previous rockfall deposits; the deposit outlined in light blue is older than the deposit outlined in dark blue.

runoff to mobilize into icy debris flows (Kochel and Trop 2012). Debris flows are responsible for transporting mostly lithic material (with minor ice) that has accumulated in the catchment area (Decaulen, 2006).

Slushflows, also known as slush avalanches, occur from major rainfall events and rapid melting of snow and ice melt from the upper-level icecap, and entrain slush type deposits on icy debris fans (Kochel and Trop, 2012; Nyberg, 1989). Kochel and Trop (2012) observed depositional slush flow deposits, with < 10% lithic material, unconsolidated smaller ice fragments, and large volumes of water, at Mueller Glacier and Douglas Glacier, New Zealand and McCarthy Glacier, Alaska. Slushflows have been observed to occur after major rainfall events, when abundant rainfall produces significant meltwater from a specific source (Decaulen, 2006; Kochel and Trop, 2012). Increase in meltwater from the upper-level icecap occurs during warmer months or during the inflow of warm air in cooler months. The rise in air temperature and major rainfall are both linked to the increase in free water from the upper-level icecap (Nyberg, 1989). The increase in free water discharges ice and lithic material temporarily stored in the catchment of icy debris fans as slushflows and icy debris flows. The free water, ice, and lithic mixture travels to the apex of the fan and moves onto the fan, producing lobate deposits (Bull et al., 1995; Kochel and Trop, 2012). The water in glacial systems can build up within the drainage systems, through time, due to the lack of large channels to release water at atmospheric pressure, known as free flow (Knight, 1999). The passages that water travels through are located in inclusions within and between ice crystals causing a greater pressure than atmospheric pressure (Knight, 1999). The water pressure tends to increase in cooler months, due to the decrease in drainage routes, and the pressure will increase more rapidly in the early spring when melt water is becoming more abundant, again (Hooke et al. 1990). At La Perouse, slushflows are more common in cooler months (Figure 20), indicating major change in ice pressure, water pressure, and major water inputs on the drainage system (Knight, 1999). These variables are linked to the direct release of ice from the upper level icecap, therefore, transports ice and minor lithic material highly saturated in water to icy debris fans.

Rockfalls are a major principal erosional mechanism that controls the morphology of alpine terrains (Rapp, 1960; Ballantyne, 2002; Moore, 2009). The topography and climate has a large impact on the rate of rockfalls, as well. These major mass movements are forces caused by changes to permafrost, chemical weathering, tectonic affects, and the retreat of glaciers, which creates additional bedrock exposures (Schober et al., 2012). When steeply sloped bedrock is exposed gravity forces will take place transporting loose material down slope (Moore, 2002; Dussauge, et al., 2003).

Deposition on Icy Debris Fans at La Perouse Glacier

Three icy debris fans located at La Perouse Glacier were studied. Time-lapse imagery and field observations data were collected for two of the three fans at La Perouse Glacier, the Middle and East Fan. The third fan, West Fan, only has data collected from field observations. In 2013 the Middle Fan had an area of 19,097 m^2, and the East fan had an area of 16,303 m^2. The icy debris fans at La Perouse Glacier demonstrated remarkably high depositional rates. Figure 15 illustrates the total number of deposits for each individual month on both the Middle and East Fan over the nine month time period. The majority of the deposits were ice avalanches (92%), followed by debris flows, slushflows, and rockfalls which together accounted for 8% of recorded events. The number of depositional events that occurred over the nine months of time-lapse imagery (Figure 15) for the East and Middle Fan included 282 ice avalanches, 15 debris flows, 10 slushflows, and

1 rockfall. The Middle Fan experienced 201 ice avalanches, 14 debris flows, 9 slushflows, and 1 rockfall (Table 3). The East Fan experienced 81 ice avalanches, 1 debris flow, 1 slushflow, and no rockfalls (Table 3). Of the 308 depositional events that occurred at La Perouse Glacier, 225 occurred on the Middle Fan and 83 on the East Fan. At La Perouse Glacier study site there was an average of 0.3 to 0.9 events that occurred per day per fan. Deposits on the Middle Fan covered 2,043% of the fan area, while deposits on the East Fan covered 714% of the fan area. The number of events that occurred each day correlates with the area covered during that day during the nine month observation period. For example, Figure 16 illustrates 2 major depositional events on 23 March 2013 that covered 30% of fan area, where 7 major depositional events on 31 March 2013 covered 69% of fan area. For the Middle and East Fan the maximum volume of a single major depositional event was 14,959 m^3 and a minimum of 147 m^3 (Table 4). The Middle Fan had an average single event volume of 2,159 m^3, and the East Fan of 3,572 m^3. Taken together, the average volume for depositional event was 2,865 m^3 (Table 4).

The time-lapse imagery did not record small scale events the remained in the catchments, only major events that emerged onto the fans. Field observations did record small events that occurred in the catchments. From March 9-16, 2014, field observations recorded 7 major ice avalanche deposits on 2 fans over a 2 day time period, and 93 smaller events that occurred in the catchment. The events were recorded over a 2 day time period for only ~7 hours each day. Field observations indicate 5-6 major depositional events that occur per day per fan, and 25-63 smaller events likely occur per day per fan.

The Middle and East Fan show differences in the temporal nature of depositional processes. The East Fan was more active during winter months, but the Middle Fan’s pace decreased during winter months (Figure 17). Figure 17 shows that debris flows and slushflows only occur after major rainfall events, and ice avalanches also occur at higher rates following significant rainfall. In warmer months the upper-level icecap melting may be the primary cause of ice avalanches in the absence of rainfall. The timing, frequency, and depositional process types between fans are attributable to variations in catchment morphology and linkage to the ice/snow supply in the névé region. Figure 3 illustrates this difference. The East Fan is not well connected to the La Perouse Névé, where the Middle Fan is more directly connected. The ice avalanche deposits on the East Fan in cooler months most likely come from winter snow buildup in the upper catchment, and it has considerably less contribution from the névé region (the connection is smaller). The upper catchment is developed from the foliation of the bedrock. This catchment is not as developed for the Middle Fan, but activity is still seen in the winter months on this fan due to the direct connection to the névé. However, both icy debris fans demonstrate a continual active deposit pace throughout the seasons.

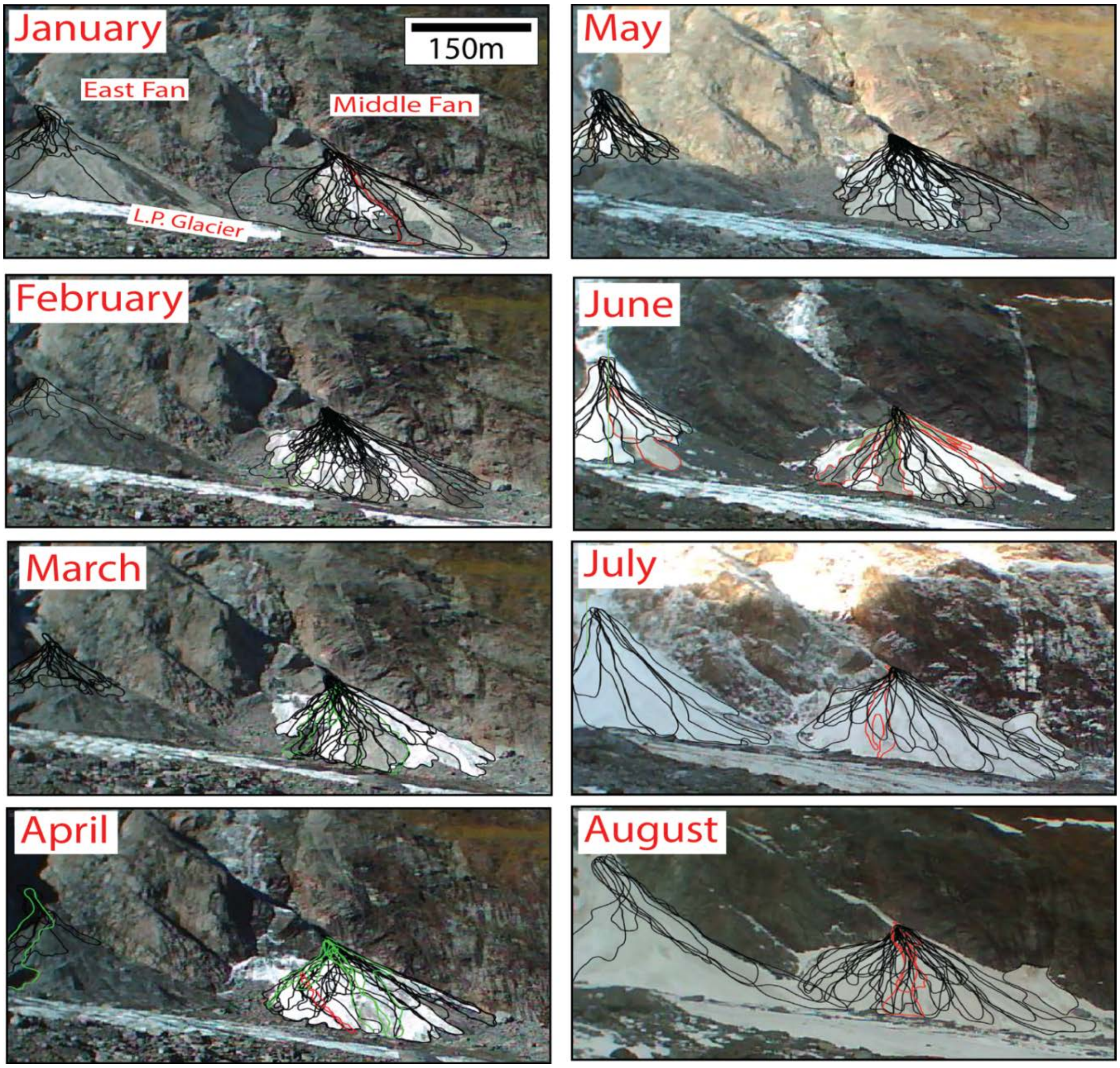


Figure 15. The time-lapse imagery recorded many mass flow deposits at La Perouse Glacier, 2013. Each photograph, collected from camera LP3, illustrates the total number events that occurred over a month interval by digitizing individual mass flow deposits. For La Perouse Glaicer nine months of data was recorded, January 12, 2013 – September 8, 2013. Black polygons are ice avalanches, red are slush flows, green are debris flows, and yellow are rockfalls.

Table 3. The total number of different mass wasting events that occurred on both icy debris fans, Middle and East, at the La Perouse Glacier.   For consistency place table captions at the top

Mass Wasting Process	**Total Number of Deposits on the Middle Fan**	**Total Number of Deposits on the Middle Fan**	**Total Number of Deposits at La Perouse Glacier**
Ice Avalanches	201	81	282
Debris Flows	14	1	15
Slushflows	9	1	10
Rock Falls	1	0	1
Total	225	83	308

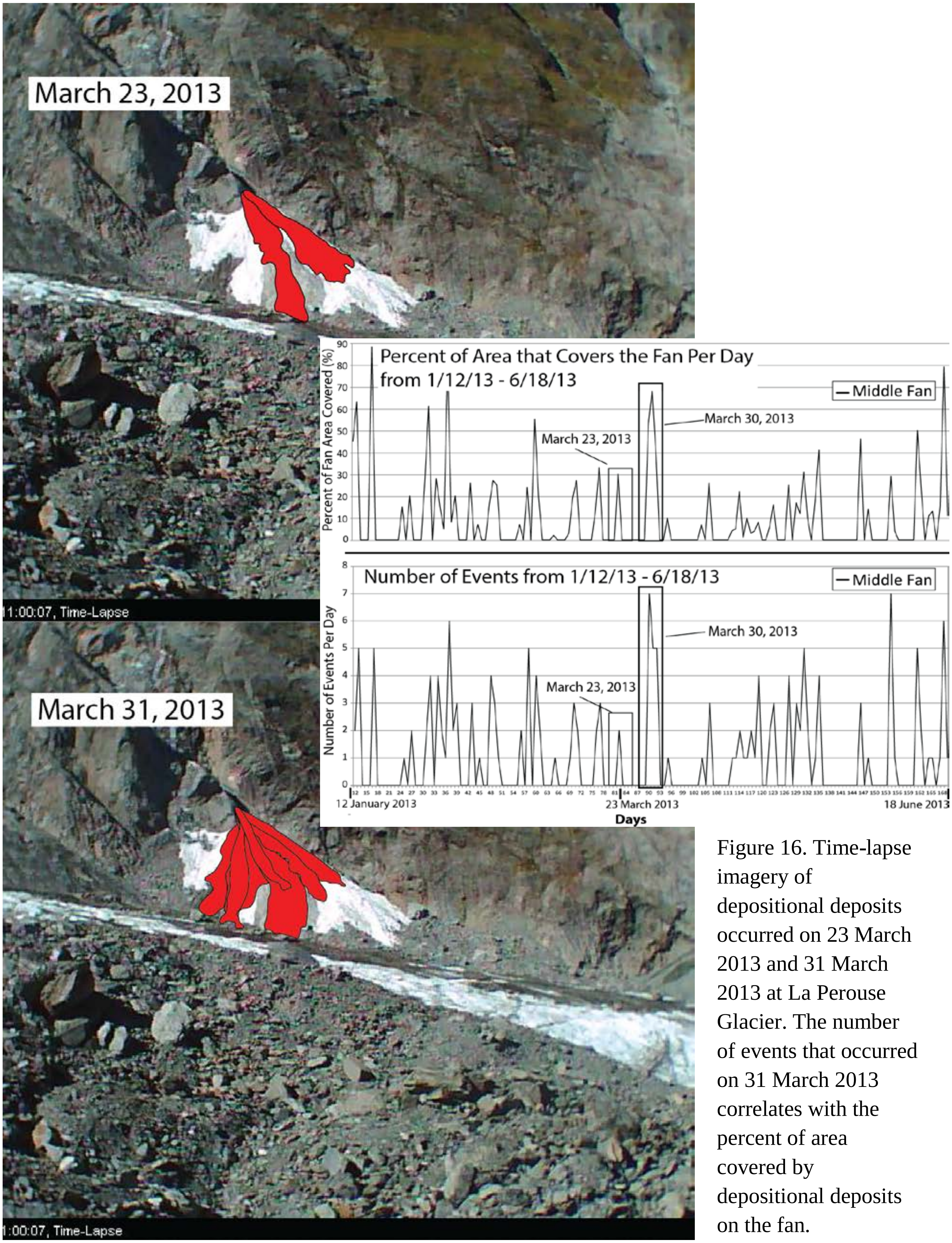


Figure 16. Time-lapse imagery of depositional deposits occurred on 23 March 2013 and 31 March 2013 at La Perouse Glacier. The number of events that occurred on 31 March 2013 correlates with the percent of area covered by depositional deposits on the fan.

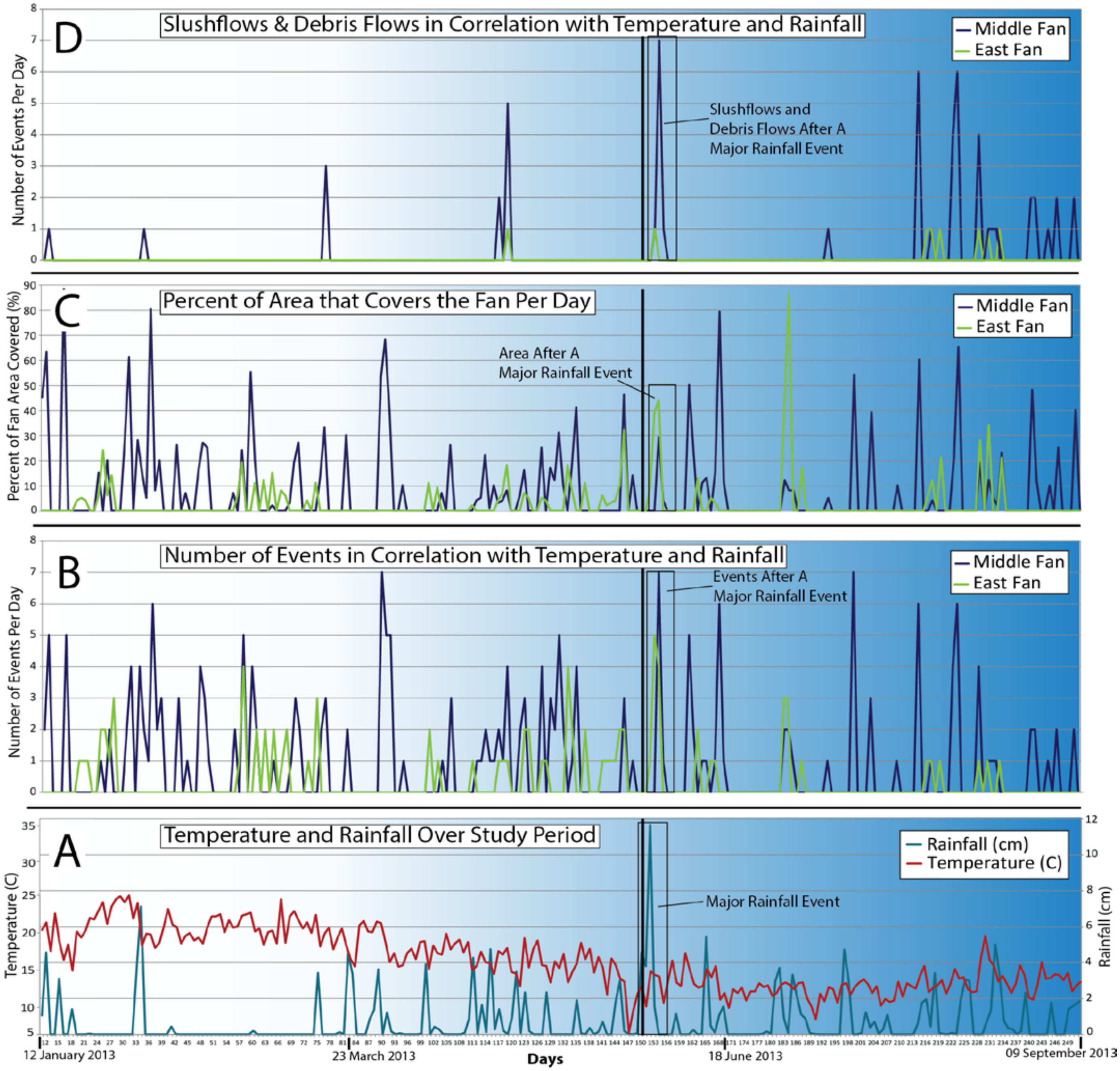


Figure 17. A) The Temperature and rainfall measurements over the study period. The weather measurements were recorded from Franz Josef Glacier, 22 km North of La Perouse Glacier. B) The total number of all events on the Middle and East Fans at La Perouse in relation to temperature and rainfall over nine months. C) The total percentage of fan area covered by all events on the Middle and East Fans at La Perouse in relation to temperature and rainfall over nine months. C) Additionally, the number of slush flows, debris flows, and rockfalls in relation to temperature and rainfall.

Table 4. The total number of events, the minimum and maximum volume of a single event, the entire fan area covered, and the average event volume at La Perouse Glacier.

La Perouse Glacier	**Total Events**	**Minimum Volume**	**Maximum Volume**	**Fan Area Covered**	**Average Event Volume**
Middle Fan	225	147 m^3	8,752 m^3	2,043%	2,159 m^3
East Fan	83	720 m^3	14,959 m^3	714%	3,572 m^3
Total	308	867 m^3	23,711 m^3	2,757%	5,734 m^3

Deposition on Icy Debris Fans at Douglas Glacier

At Douglas Glacier five icy debris fans were studied with the aid of both time-lapse imagery and field observations. Fan 1 had an area of 15898 m^2, Fan 2 of 5346 m^2, Fan 3 of 9952m^2, Fan 4 of 26899 m^2, and Fan 5 of 5633 m^2. All five fans, similar to the three fans at La Perouse Glacier, experienced high depositional rates in 2013. Figure 18 illustrates the history of depositional events that occurred on each five fans over an eight month time-lapse imagery period, 8 January 2013 to 20 August 2013. The major depositional processes at Douglas Glacier were ice avalanches (98%), with 1.2% slushflows, 0.46% rockfalls, and no icy debris flows. Icy debris flows appear to be uncommon at Douglas Glacier, due to the inability to collect lithic debris in poorly developed catchments.

The icy debris fans are comprised of a pulverized ice cover; events on Douglas lack agglomeration because of ;imited transport distance from the neve source and limited catchment area. Ice wasted from the neve quickly calves or ‘rockets’ over the edge of the escarpment and is deposited on the icy debris fan before agglomeration can occur.

Over the eight months of time-lapse imagery there were 635 ice avalanches deposits, eight slushflow deposits, three rockfall deposits, and no icy debris flow deposits. Fan 1 had 106 ice avalanches deposits, one slushflow deposit, and no icy debris flow deposits (Table 5). Fan 2 had 16 major ice avalanche deposits and no other deposits. Fan 3 had 133 ice avalanches, seven slushflows, and two major rockfalls recorded. Fan 4 had 298 ice avalanche deposits and one rockfall deposit. Fan 5 had only 82 ice avalanche deposits. Douglas Glacier icy debris fans experienced 16-299 deposits per fan over an eight month interval, (averaging between 0.07 and 1.32 deposits per day per). Fan activity decreased in cooler months, but remained active throughout the year. Likewise, the percent of fan area covered by depositional events decreased during the winter (Figure 18).

Deposits from 8 January 2013 to 20 August 2013 on Fan 1 deposits covered 1,155% of the fan area; deposits on Fan 2 covered 598% of the fan area; deposits on Fan 3 covered 3,447% of the fan area; deposits on Fan 4 covered 2,221% of the fan area; and deposits on Fan 5 covered 1,806% of the fan area (Table 4). The number of events that occurred each day correlates with the area covered during that day. For example, Figure 19 illustrates all 16 ice avalanche deposits that occurred on 30 April 2013, on Fan 4 and all deposits covered 125% of fan area. The average deposit volume ranged from 5,346 to 26,900 m^3, where Fan 1 had an average deposit volume of 15,898 m^3, Fan 2 had an average deposit of 5,346 m^3, Fan 3 had an average deposit of 9,952 m^3, Fan 4 had an average deposit of 26,900 m^3, and Fan 5 had an average deposit of 5,634 m^3 (Table 6). Most of the depositional deposits occurred after a significant rainfall event (Figure 20), because as water moves through the ice it produces frictional heat, which melts some of the surrounding ice (Benn and Evanns, 1998). Additionally, in warmer months icecap melting may be the primary cause of ice avalanches in the absence of rainfall, which relates to the meltwater exceeding drainage network capacity and the production of frictional heat (Knight, 1999).

As previously stated, the time-lapse imagery did not document small scale depositional events. Field observations were made on the day of 3/14/2014 at Douglas Glacier. In 2013 there were a number of >150 small scale events that occurred during the seven hours, with ~200 small scale events per day. Only two major events were recorded during the field reconnaissance. Additionally, variances in the timing, frequency, and depositional process types between fans at Douglas Glacier are attributable to the catchment morphology and linkages to the ice/snow supply in the névé regions.

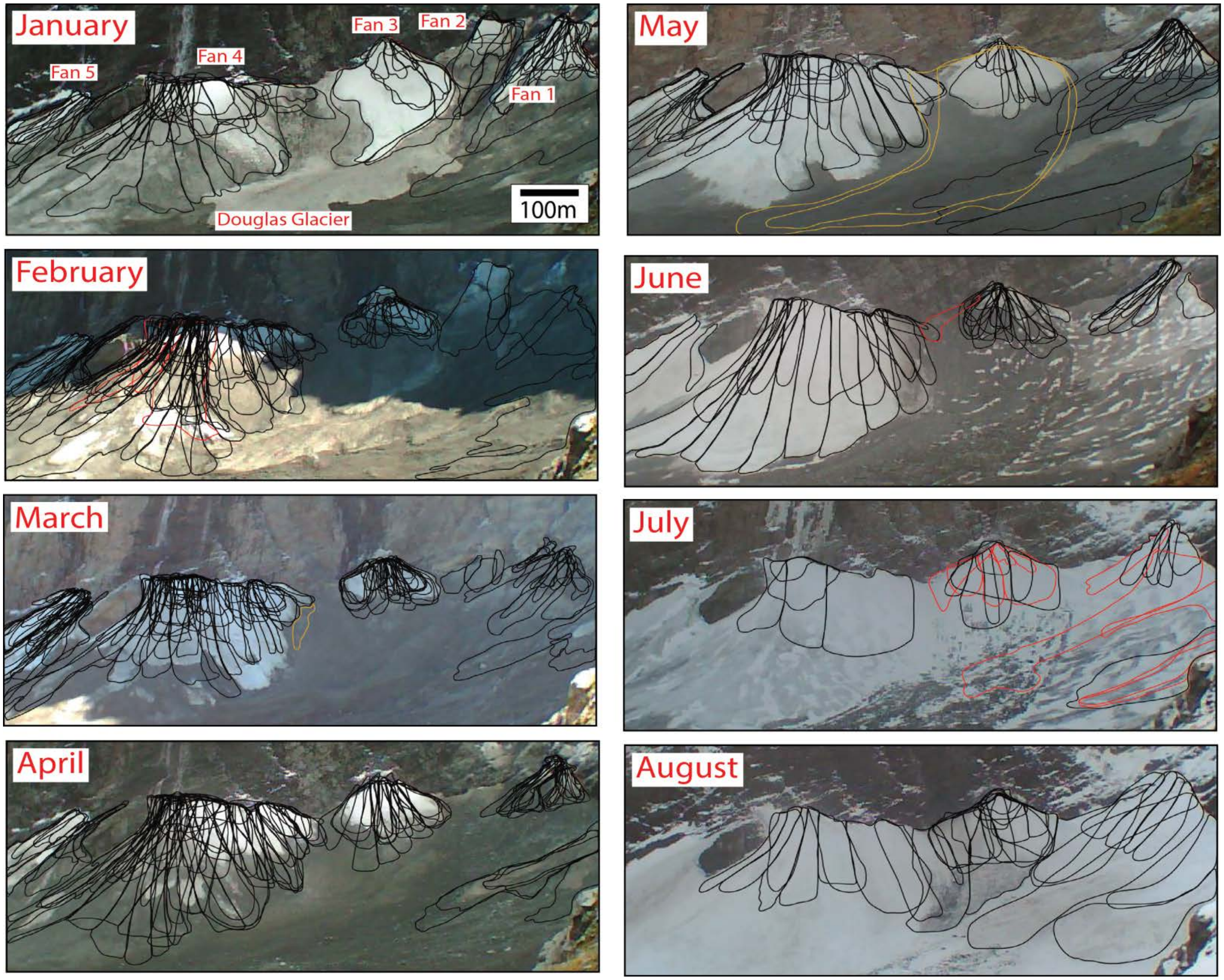


Figure 18. The time-lapse imagery recorded many mass flow deposits at Douglas Site. Each photograph, collected from camera D2, illustrates the total number events that occurred over a month interval by digitizing individual mass flow deposits. For the Douglas site eight months of data was recorded, January 8, 2013 – August 20, 2013. Black polygons are ice avalanches, red are slush flows, green are debris flows, and yellow are rockfalls.

Table 5. The total number of different mass wasting events that occurred on icy debris fans, Fans 1-5, at the Douglas check the captions and the numbering on the tables Glacier.

Mass Wasting Process – Douglas Glacier	Total Number of Deposits on Fan 1	Total Number of Deposits on Fan 2	Total Number of Deposits on Fan 3	Total Number of Deposits on Fan 4	Total Number of Deposits on Fan 5	Total Number of Deposits at Douglas Glacier
Ice Avalanches	106	16	133	298	82	635
Debris Flows	0	0	0	0	0	0
Slushflows	1	0	7	0	1	9
Rock Falls	0	0	2	1	1	4
Total	107	16	142	299	82	648

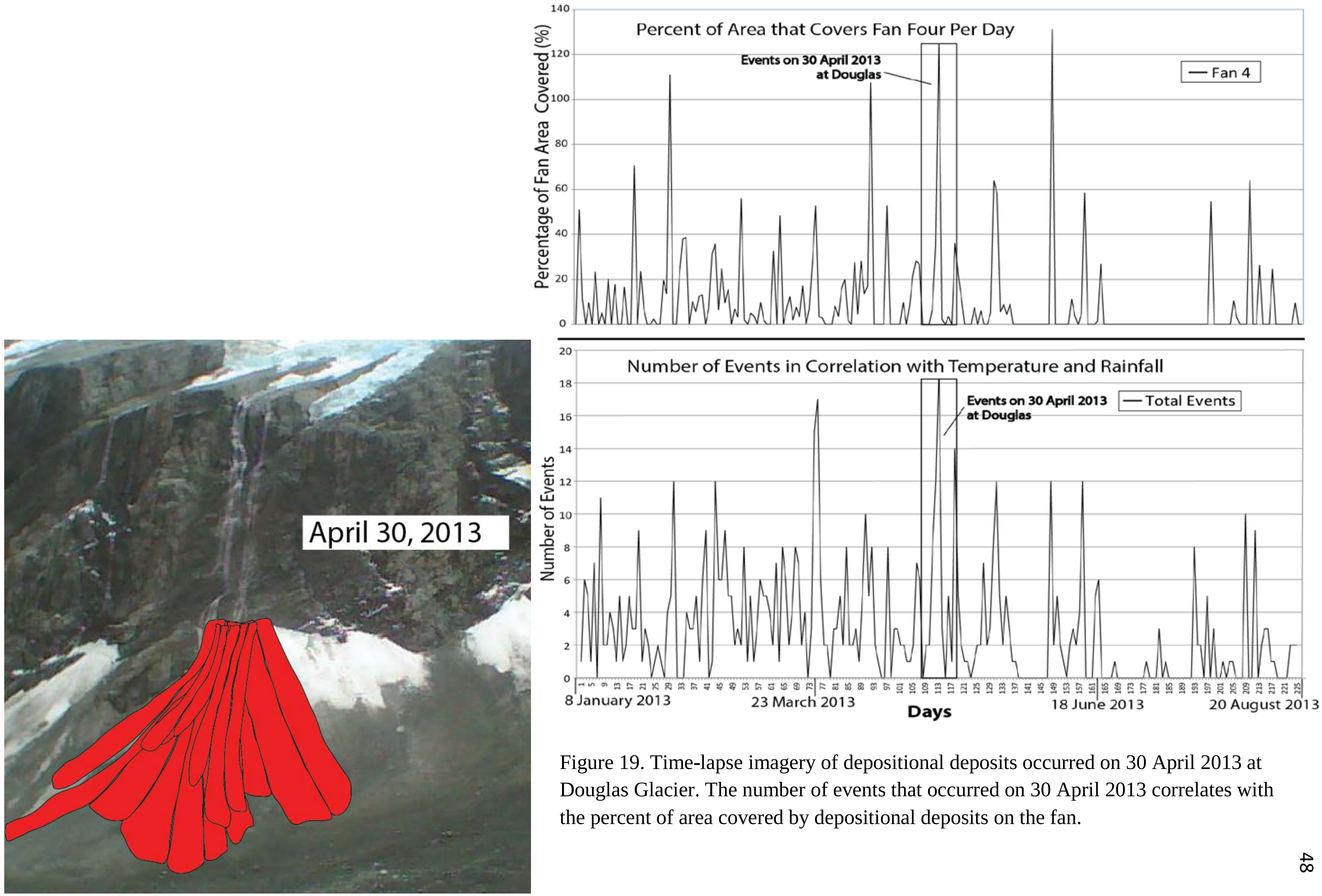


Figure 19. Time-lapse imagery of depositional deposits occurred on 30 April 2013 at Douglas Glacier. The number of events that occurred on 30 April 2013 correlates with the percent of area covered by depositional deposits on the fan.

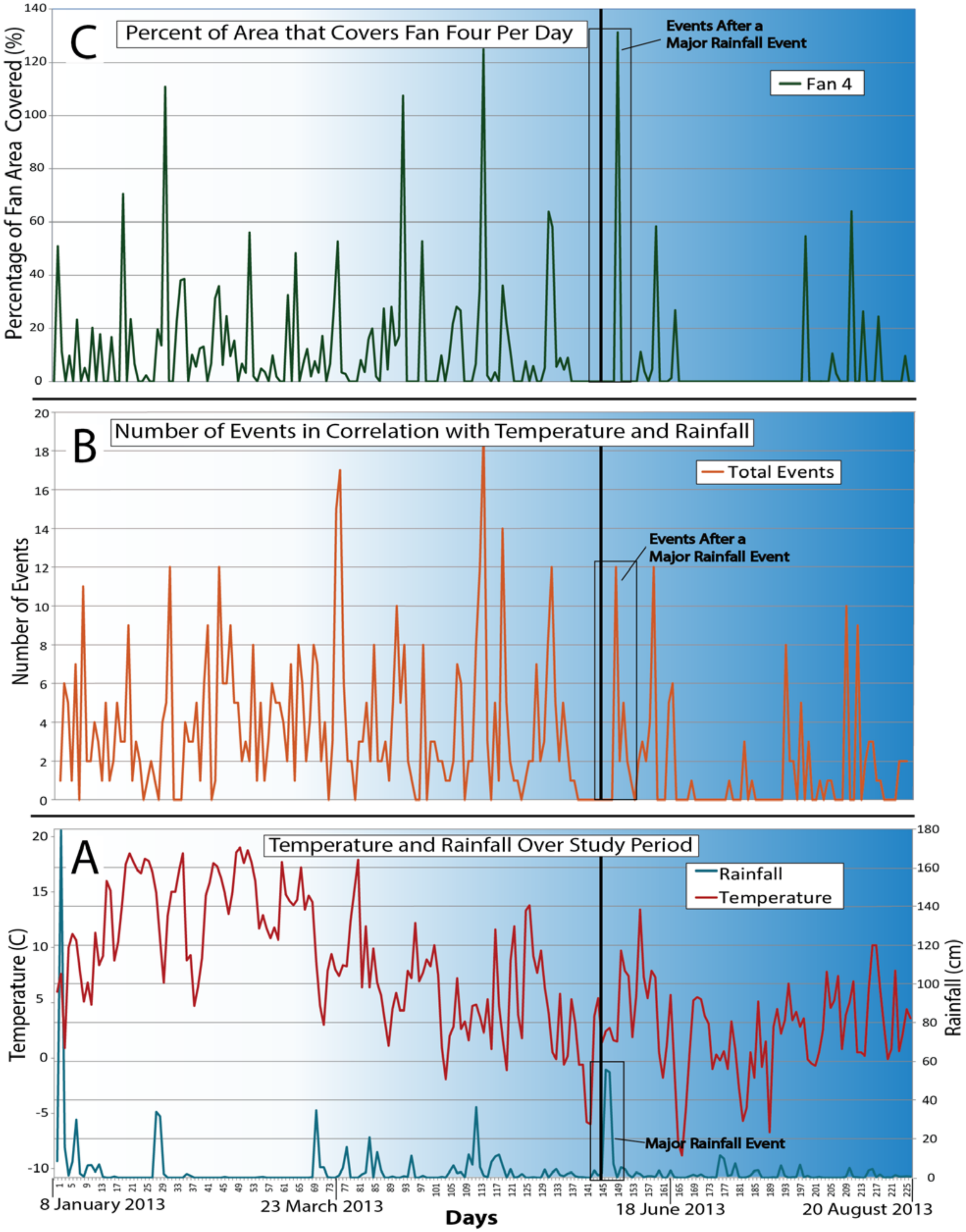


Figure 20. A) The recorded temperature and rainfall over the study period. Weather measurements were taken from Fox Glacier, 20 km from Douglas Glacier. B) Total number of events on all of the fans at Douglas Glacier, in relation to temperature and rainfall. C) The total percentage of fan area covered by events on Fan 4 at Douglas Glacier, in relation to temperature and rainfall.

Table 6. The total number of depositional events, the minimum and maximum volume of a single event, the entire fan area covered, and the average event volume. The Mount Sefton deposits were sourced from Mount Sefton, and the entirety of the deposits were not captured on the time-lapse imagery.

Douglas Glacier	Total Events	Minimum Volume	Maximum Volume	Fan Area Covered	Average Event Volume
Fan 1	107	480 m^3	69,872 m^3	1,155%	15,898 m^3
Fan 2	16	913 m^3	14,543 m^3	598%	5,346 m^3
Fan3	142	835 m^3	90,597 m^3	3,447%	9,952 m^3
Fan 4	299	727 m^3	70,579 m^3	2,221%	26,900 m^3
Fan 5	82	427 m^3	10,828 m^3	1,806%	5,634 m^3
Mount Sefton	16	1,139 m^3	75,808 m^3	--	--
Total	662	4,523 m^3	332,227 m^3	9,227%	63,730 m^3

Area and Volume Measurements for La Perouse Glacier and Douglas Glacier

Supraglacial icy debris fans add material to the accumulation zones of glaciers and are often neglected in glacial mass balance calculations. Understanding the amount of material being added to the valley glaciers by icy debris fans will contribute to a better understanding of the glacier's behavior, and annual glacial ice budgets, especially during the current pace of global warming.

Area

The 2013-2014 area of La Perouse Glacier was estimated to be ~4,000,000 m^2, and the icy debris fans studied have a combined total area of 57,291 m^2. The Middle Fan has an area of 16,303 m^2, the area of East Fan is 19,097 m^2, and the area of West Fan is 21,891 m^2. By area, the three icy debris fans studied at La Perouse Glacier equal 1.4% of the La Perouse Glacier. Additionally, the Douglas Glacier has an estimated area of ~2,000,000 m^2. The area of Fan 1 being 15,898 m^2, Fan 2 has an area of 5,346 m^2, Fan 3 has an area of 9,952 m^2, Fan 4 has an area of 26,899 m^2, and Fan 5 has an area of 5,633 m^2, with a combined total area of 63,728 m^2. The icy debris fans equal 3.2% of the total area of Douglas Glacier.

Volume

The total material being added from 12 January 2013 to 8 September 2013 to the La Perouse Glacier via icy debris fans is ~1,045,699 m^3. The Middle Fan contributes 893,495 m^3 of icy and lithic material, and the East Fan contributes 152,204 m^3 of icy and lithic material from the upper icecap. At Douglas Glacier the total of depositional material being added yearly to the valley glacier via icy debris fans is ~4,483,507 m^3. Fan 1 contributes 595,754 m^3 of icy and lithic material, Fan 2 contributes 103,726 m^3 of icy and lithic material, Fan 3 contributes 1,112,851 m^3 of icy and lithic material, Fan 4 contributes 330,023 m^3 of icy and lithic material, and Fan 3 contributes 403,170 m^3 of icy and lithic material. All of the calculated material is not all being directly added to the valley glacier, some material is eliminated by ablation. Using the data from the 2013 TSL/LiDAR surveys (Figure 21), the Middle Fan at La Perouse Glacier has an estimated volume of 1,768,515 m^3, the East Fan of 2,602,081 m^3 and West Fan volume equals 1,064,108 m^3. The total volume of material added to the two icy debris fans at La Perouse during 2013 was approximately 5,434,081 m^3 (Table 7). Additionally, at Douglas Glacier, Fan 1 has an estimated volume of 1,099,853 m^3, Fan 2 of 1,073,725 m^3, Fan 3 of 1,679,888 m^3, Fan 4 of 2,355,278 m^3, and Fan 5 of 2,950,266 m^3. Total volume of the Douglas fans studied is approximately 9,159,010 m^3 (Table 8). It is important to note that there are additional icy debris fans that are at both La Perouse Glacier and Douglas Glacier. These additional icy debris fans are larger in size and are not taken in account in the complete total volume of material contributed via icy debris fans to the valley glacier. The total icy debris fan volume contribution to the valley glacier is a minimal value, and is likely significantly underestimated.

Icy debris fans at La Perouse Glacier and Douglas Glacier are not pro-grading out onto the glacier, nor changing geometry, but rather are maintaining a quasi-equilibrium form. Figure 22 is a schematic cross-section of an icy debris fan illustrating the subsurface and demonstrating how ablation and flow of the glacier affect the growth of an icy debris fan. The decrease of snow mass from melt and sublimation, also known as ablation, is shown in blue in Figure 21. According to Dyer and Thomas (2006) snow melt is caused by the radiative balance, variation in air temperature, and surface energy fluxes. Short-term ablation data was collected in the field at both Douglas Glacier and La Perouse Glacier. Short-term ablation was collected in late summer, when ablation would be expected to be at a peak. Ablation is expected to be much less significant in cooler months. The ablation data was collected by inserting multiple stakes into various deposits across different fans. At La Perouse two stakes recorded ablation for 4 days on the West Fan: stake LP-2 recorded 31.5 inches of ablation and LP-3 recorded 34 inches of ablation. Two stakes recorded ablation for one day on the East Fan: LP-4 had 7 inches and LP-5 had 1.5 inches of ablation. At Douglas Glacier only one stake recorded ablation data: two inches over a 10 hour study period. The data collected at La Perouse Glacier indicates that a single depositional event not covered by a newer event could ablate 44% over 4 days during the warm summer season.

The other parameter is the movement of the valley glacier, the flow, shown as the two red arrows in Figure 22, which allows icy debris fans to stay at an equilibrium form. The flow of glaciers is the combination of two mutually independent processes, creep and sliding. Creep is the internal deformation of the glacier, and sliding is the movement along the base and sides (Ritter et al., 2011). Using Google Earth and time-lapse aerial photos, I calculated that the La Perouse valley glacier has moved a total of 173 m/yr. from 2006 to 2012, and the Douglas valley glacier has moved a total of 27 m/yr. from 2006 to 2012. This was calculated based on the Google Earth and time-lapse imagery showing rock movement. The ice and lithic material are transferred from icy debris fans (the location of accumulation) to the glacier, and then transported down to areas of the glacier known as the ablation zone. The glacier is divided into two parts, the accumulation zone and the ablation zone. The accumulation zone is the area where accumulation exceeds ablation, and the ablation zone is where ablation exceeds accumulation. When the entire glacier system is in balance, the rate at which the glacier flows is correlated to the amount of accumulation and loss of ice and snow material (Benn and Evans; 2010). Additionally, the glacier with the larger accumulation volume and greatest loss will have a bigger geomorphic impact on the area (Ritter, Kochel, Miller; 2011).

Both the accumulation and ablation determines the level of glacial activity. The amount of material being added from the upper-level ice caps, through icy debris fans, and to the glacier has to be taken in account to understand a glacier's ice budget. For example, at La Perouse there are three active icy debris fans contributing 5,434,081 m^3 amount of material annually to the valley glacier. The La Perouse Glacier has an estimated area of ~4,000,000 m^2. La Perouse Glacier has a rough volume of ~350,000,000 m^3. At the Douglas site there are five active icy debris fans contributing 9,159,010 m^3 of ice and lithic material annually. The estimated area of the Douglas Glacier is ~2,000,000 m^2 and has a volume of ~200,000,000 m^3. The volume of material added to Douglas Glacier from icy debris fans is 3,725,029 m^3 greater than icy debris fans at La Perouse Glacier. Icy debris fans at both locations contribute to the dynamic of the valley glacier,

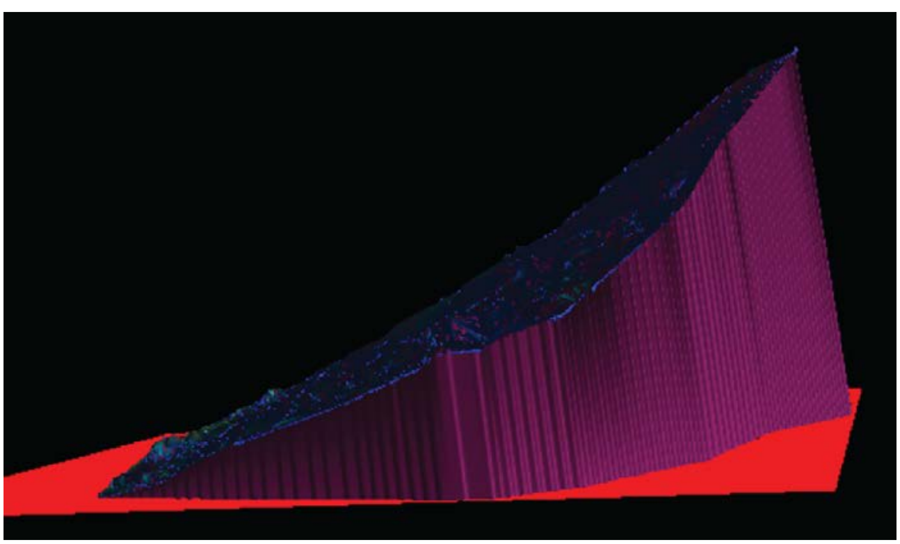


Figure 21. Inferred three-dimensional block model of the Middle Fan at La Perouse Glacier. Blue points represent perimeter of fan surface topography determined from TLS survey. Red Rectangle represents a plane inserted below the fan at the elevation of the glacier near the fan terminus. Purple rectangles represent inferred subsurface fan deposits, with an estimated max volume of 1,700,000 m^3.

adding material to the accumulation zone of a valley glacier. The three icy debris fan volume contributions annually are 1.6% of the total La Perouse Glacier volume, while five icy debris fan volume contributions annually are 4.6% of the Douglas Glacier.

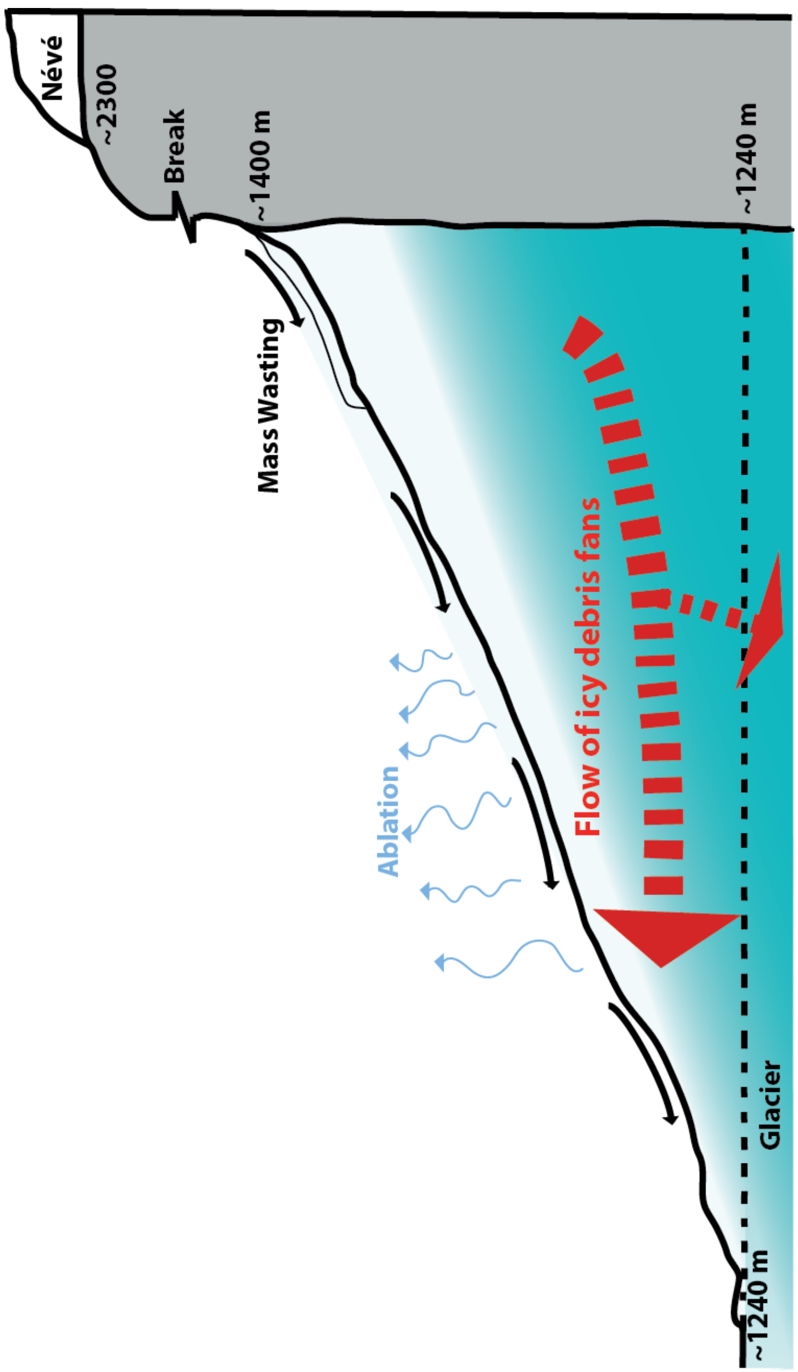


Figure 22. A schematic cartoon cross section is viewing the subsurface of an icy debris fan, transitioning from the upper-level ice cap to the underlying valley glacier, could either be La Perouse Glacier or Douglas Glacier. The ice and lithic-rich deposits, that comprise the fan, come from the upper-level ice cap. These deposits start to flow, and eventually merge with the underlying valley glacier, indicated by the red arrows. The ablation, indicated by the blue arrows, melts the deposits. Both, flow of the glacier, and ablation, play a major role in the growth of the fan.

Table 7. Maximum volumes for icy debris fans at La Perouse Glacier.

Fan at La Perouse	**Volume**	**Area**
East Fan	1,768,515 m^3	19,097 m
Middle Fan	1,064,108 m^3	16,303 m
West Fan	2,602,081 m^3	21,891 m
Total Icy Debris Fans	5,434,703 m^3	57,291 m
La Perouse Glacier	~350,000,000 m^3	4,000,000 m

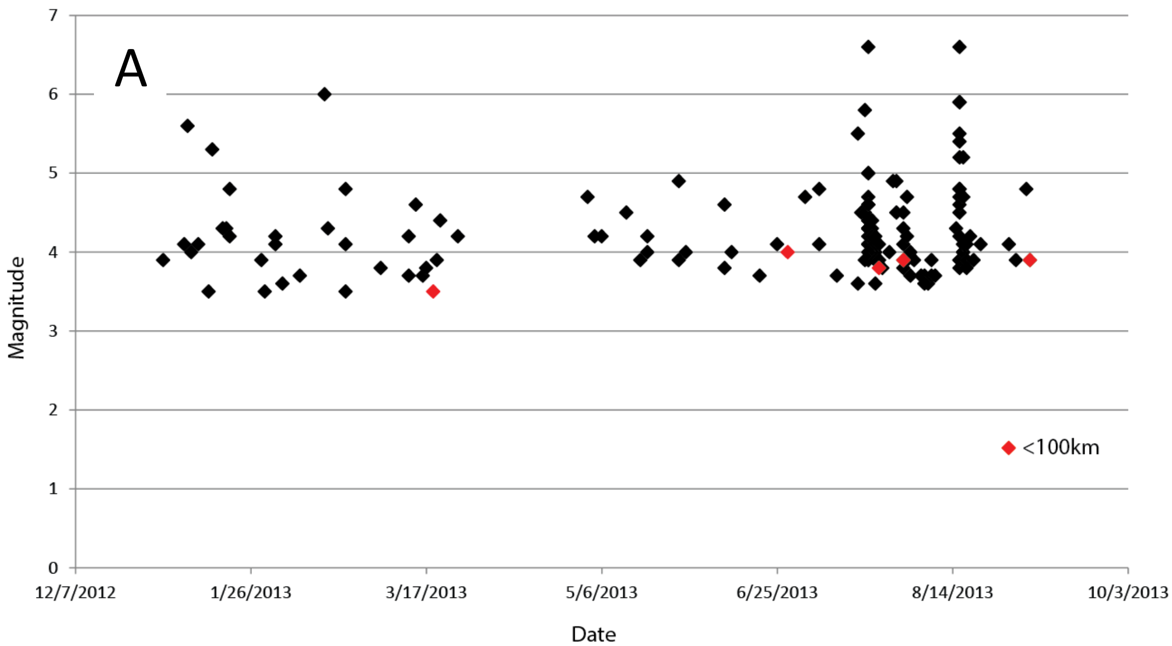
Table 8. Maximum volumes for icy debris fans at Douglas Glacier.

Fan at Douglas	**Volume**	**Area**
Fan 1	1,099,853 m^3	15,898 m
Fan2	1,073,725 m^3	5,346 m
Fan3	1,679,888 m^3	9,952 m
Fan 4	2,355,278 m^3	26,899 m
Fan 5	2,950,266 m^3	5,633 m
Total Icy Debris Fans	9,159,010 m^3	63,728 m
Douglas Glacier	~200,000,000 m^3	2,000,000 m

RELATED DATASETS

Seismicity During Deposition

New Zealand is a tectonically active environment (Cox and Findlay, 1995). A total of 154 earthquakes were recorded from GeoNet in New Zealand from 1 January 2013 to 5 September 2013, with magnitudes ranging from 3.5 to 6.6, with 1 to 19 earthquakes that occurred in a single day (Figure 23 a.). Five earthquakes occurred within less than 100 km of both the La Perouse Glacier and Douglas Glacier study site (Figure 23 b.). The first of the five earthquakes was on 19 March 2013 with a magnitude of 3.5, the next on 30 May 2013 with a magnitude of 4.0, 18 July 2013 with a 3.6 magnitude, 9 August 2013 with a 3.7 magnitude, and 5 September 2013 with a 3.9 magnitude. Figure 24 plots the total number of events that occurred on the Middle Fan (Blue) and East Fan (Green) against the number of earthquakes (Red) that occurred that day. There is not a significant correlation between icy debris fan deposits and earthquake occurrences; the five earthquakes located less than 100 km from La Perouse and Douglas Glacier determine this. The closest of the five earthquakes and the second strongest occurred on 5 September 2013 with no mass wasting events that day or the next for La Perouse Glacier, Figure 25 illustrates the total number of events that occurred on Fans 1 (Green), 2 (Purple), and Mount Sefton deposits (Blue) in correlation with the number of earthquakes (Red) that occurred that day. Figure 26 illustrates the same except it plots Fans 3 (Purple), 4 (Green), and 5 (Blue). Additionally, these plots show no correlation between the occurrence of events and earthquake data. 30 May 2013 was the strongest earthquake within 100 km of both sites and the second closest, with zero events occurring that day or the next at Douglas Glacier (there is no time-lapse imagery for 5 September 2013 for Douglas Glacier). In summary, there are no correlations between depositional



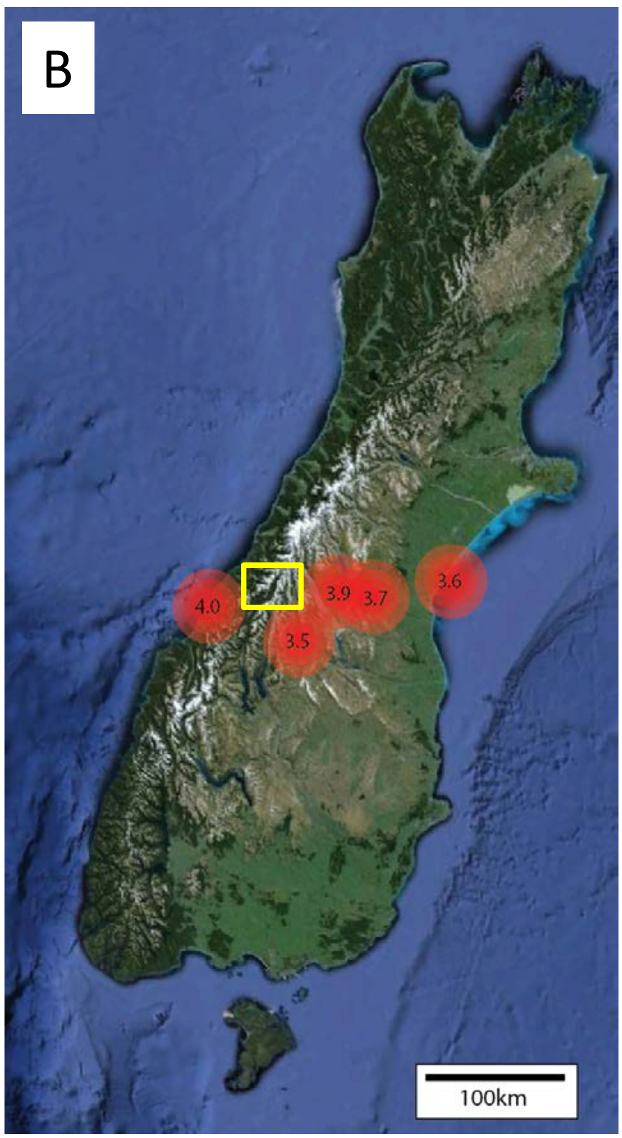


Figure 23. Earthquake data, from 1 January 2013 to 5 September 2013, collected from GeoNet, A total of 154 earthquakes with magnitudes ranging from 3.5 – 6.6. A) The plot shows the occurance of earthquakes over time in 2013.. The red indicates earthquakes that occurred within 100 km from la Perouse and Douglas Glacier. B) the map shows five different earthquake epicenters within 100km from the study sites. Yellow box indicates location.

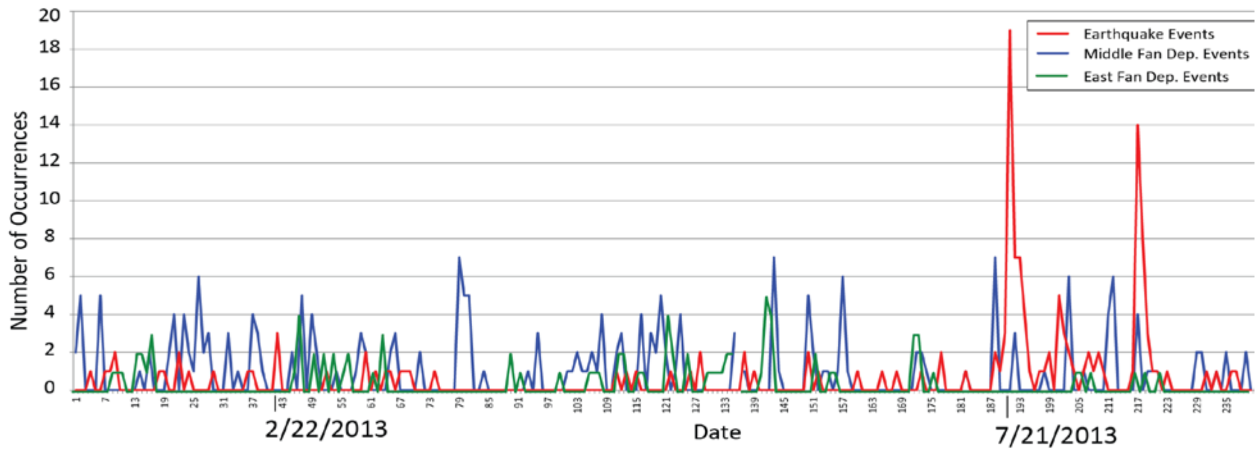


Figure 24. Earthquake data collected from GeoNet, from 5 January 2013 to 5 September 2013, in relationship of all the events that occurred on the Middle and East Fan at La Perouse Glacier during that time frame. Note, the lack of increase in depositional events following earthquakes (e.g. 21 July 2013).

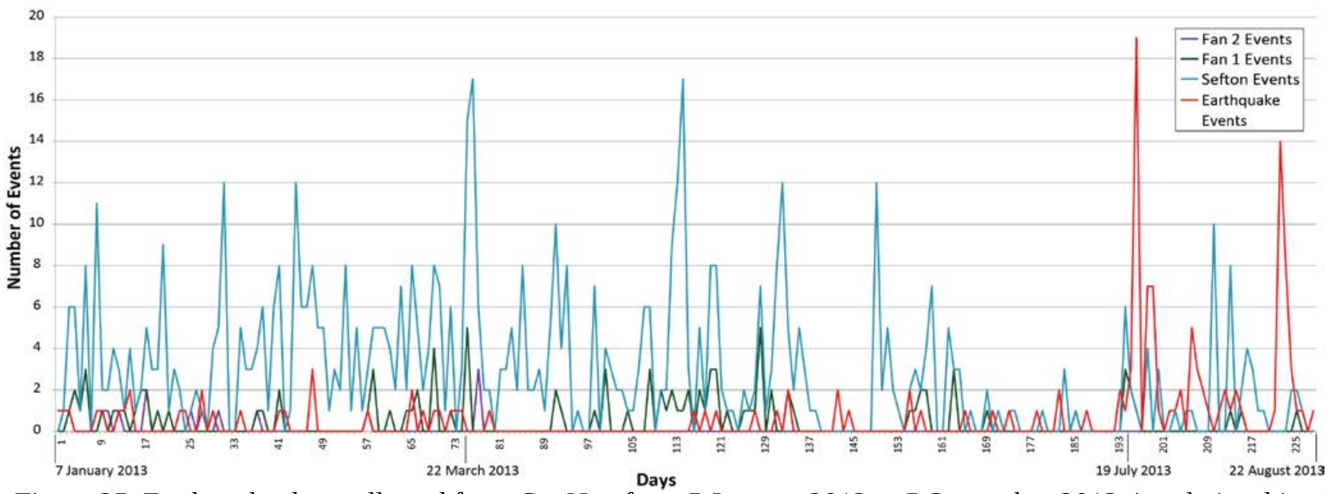


Figure 25. Earthquake data collected from GeoNet, from 5 January 2013 to 5 September 2013, in relationship of all the events that occurred on Fan 1, 2, and Sefton Deposits at Douglas Glacier during that time frame. Note, the lack of increase in depositional events following earthquakes (e.g. 21 July 2013).

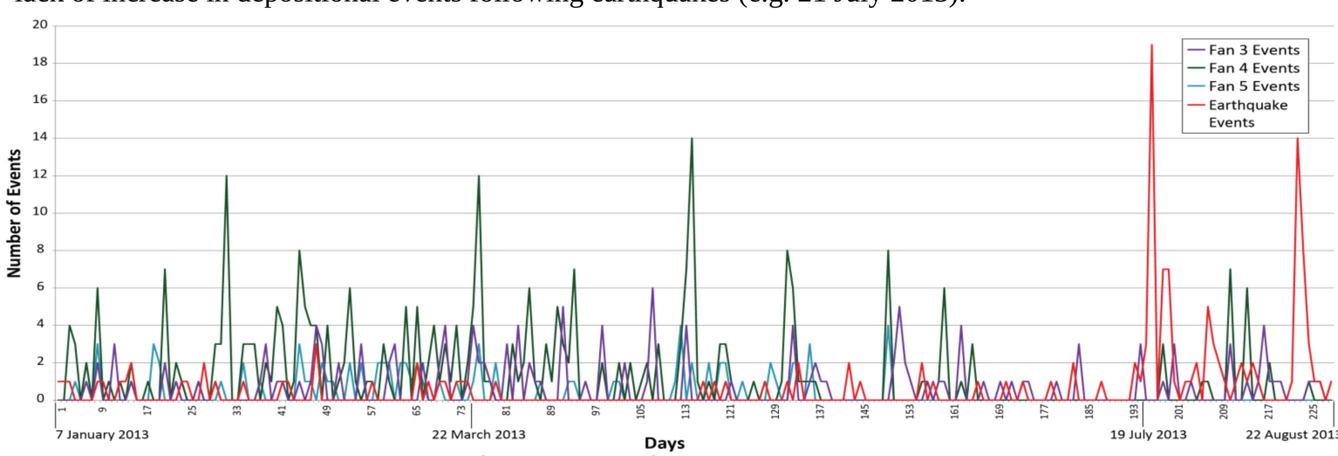


Figure 26. Earthquake data collected from GeoNet, from 5 January 2013 to 5 September 2013, in relationship of all the events that occurred on Fan 3, 4, and 5 at Douglas Glacier during that time frame. Note, the lack of increase in depositional events following earthquakes (e.g. 21 July 2013).

occurrences on icy debris fans and earthquake events from analyzing the data set collected between 1 January 2013 to 5 September 2013. The time-lapse imagery recorded two major rockfall deposits at Douglas Glacier on Fan 3. These rockfalls occurred on May 23, 2013, and can be seen in Figure 18, with a combined area of 45,298 m^2. However, the data in Figure 26 does not show activity on that day.

DISCUSSION

Icy debris fans are poorly documented landforms located in alpine areas that are undergoing deglaciation. Mass wasting of decoupled upper level icecaps focuses ice and lithic material through incised catchments to the apex of icy debris fans. Icy debris fans evolve along the margin of valley glaciers pro-grading over the valley glacier. These complex early paraglacial processes are important when degrading upper level icecaps feed material to valley glaciers. This study shows the significance of icy debris fans, with respect to the glacial budget, represent an important step in understanding the seasonal variations of these active landforms.

Time-lapse Imagery and Depositional Rates.

For the first time ever, time-lapse imagery has shown that diverse depositional processes, ice avalanches, debris flows, slushflows, and rockfalls, are active on icy debris fans throughout the year. The time-lapse cameras installed at La Perouse Glacier and Douglas Glacier in January 2013 providing images for 8-9 months, illustrating seasonal depositional fluctuation at both sites. Time-lapse imagery has shown depositional processes occur throughout the year, although rates vary seasonally. During warmer months, there is an increase in all mass wasting processes. whereas in cooler months there is a decrease in the rate of mass wasting processes.

Additionally, time-lapse imagery has confirmed that icy debris fans are formed chiefly by ice avalanches. Icy debris fans received 308 to 646 events over nine months, with ice avalanches accounting for 83-98% of depositional events. Less frequent mass wasting processes such as debris flows and slushflows only occur following significant rainfall events. The rate of significant rainfall events increases as temperature decreases; therefore the rate of debris flows and slushflows increase during cooler months (Figure 20, Figure 23). Ice avalanches and rockfalls can also occur after significant rainfall events and with an increase in temperature. Therefore, ice avalanches and rockfalls occur throughout the year. The rates of mass wasting depositional processes do not seem to be affected by minor seismic tectonic processes (Figure 7, Figure 8, Figure 9, Figure 10). However, a major seismic tectonic process could trigger an increase of mass wasting deposits on the icy debris fan. A major earthquake near the study sites has not occurred, recently.

Material Contribution.

Glaciers have an accumulation area, an ablation area, and a transfer line from the accumulation area to the ablation area (Meier, 1964). Icy debris fans are landforms within the accumulation zone where they transfer ice and lithic material onto glaciers from a variety of mass wasting processes degrading high-level icecaps. Knight (1999) explains that the life of a glacier in southern Iceland is maintained by avalanches, describing avalanches as ice being transported down a cliff face from the upper level icecap. Kochel and Trop (2012) noted that icy debris fans could potentially slow the retreat of valley glaciers, potentiall preserving the life of a valley glacier for a time (or at least slowing its decline).

The maximum volume of ice and lithic material being added from icy debris fans annually at La Perouse Glacier is 5,434,703 m^3, where the total estimated volume of the La Perouse Glacier is ~350,000,000 m^3 (Table 7). The icy debris fans measured at La Perouse Glacier contribute 1.6% of snow and lithic material in the accumulation area, and 98.4% is a different accumulation source. Figure 13 illustrates how the La Perouse Glacier is connected up valley, which could be a major source to the accumulation zone of the valley glacier. The maximum volume of ice and lithic material being added annually to the Douglas Glacier by icy debris fans is 9,159,010 m^3, where the Douglas Glacier has an estimated total volume of ~200,000,000 m^3 (Table 8). The icy debris fans at Douglas Glacier contribute 4.6% of ice and lithic material in the accumulation area. This data demonstrates that the icy debris fans at La Perouse play a significant role in the accumulation area but are not the sole source. The icy debris fans at Douglas Glacier can be inferred to play a major role in the accumulation zone. The numbers differ significantly between the two study sites because the two sites are unalike. The size of the valley glacier at La Perouse is ~150,000,000 m^3 larger than the Douglas Valley Glacier, and only three icy debris fans were measured at La Perouse Glacier, where there were five measured at Douglas Glacier. The icy debris fan volume percentage to the valley glacier volume at La Perouse Glacier could be lower than at Douglas Glacier because the La Perouse Valley Glacier is still connected to the upslope head glacier, which is not seen at Douglas Glacier, this connection is illustrated in Figure 13 Icy debris fans do contribute a significant volume to the valley glacier, affecting the glacial ice budget.

Comparisons with Other Fan Types.

There are many different types of fans that can be found in various climatic regions. Alluvial fans in arid, humid-glacial outwash, humid-tropical, humid-periglacial, and humid-temperate environments have been well studied (Figure 28), including studies on the morphology, processes, deposits, and facies, of each fan. The primary differences in dominant depositional processes of alluvial fans are related to climate and morphology factors (Kochel and Johnson, 1964).

Arid alluvial fans alternate between periods of rapid deposition and periods of inactivity, humid-glacial outwash fans evolve from braided streams constantly moving, humid-tropical fans are developed by large influxes of seasonal debris flows and braided streams, and the humid-temperate fans are characterized by irregular events of debris flows occurring after a significant rainfall event (Kochel and Johnson, 1964). Annually, arid alluvial fans typically have 10-50% of their fan area activated, humid-glacial fans up to 80-100%, humid-tropical with 30-70%, and

Table 9. The percentage of fan area activated annually on arid, debris, humid, and icy debris fans

Type of Fan	**Fan Area Activated Annually**
Arid Fan	0-50%
Debris Fan	10-70%
Humid Fan	$\leq$ 80-100%
Icy Debris Fan	1,200-2,700%

humid-temperate fans with 10-70% (Table 9). The recorded data obtained by time-lapse imagery has established that depositional rates are exceeding high. At La Perouse Glacier in nine months the Middle Fan was fully covered 15 times, and the East Fan was fully covered nine times. At

Douglas Glacier Fan 3 was fully covered 34 times, and Fan 4 was completely covered 22 times. The nature and pace of activity on debris and stream flow dominated alluvial fans are much lower than the high depositional rates seen on icy debris fans. Icy debris fans will annually have 1,200-2,700% of the fan area activated, a pace that far excees depositional rates (resurfacing

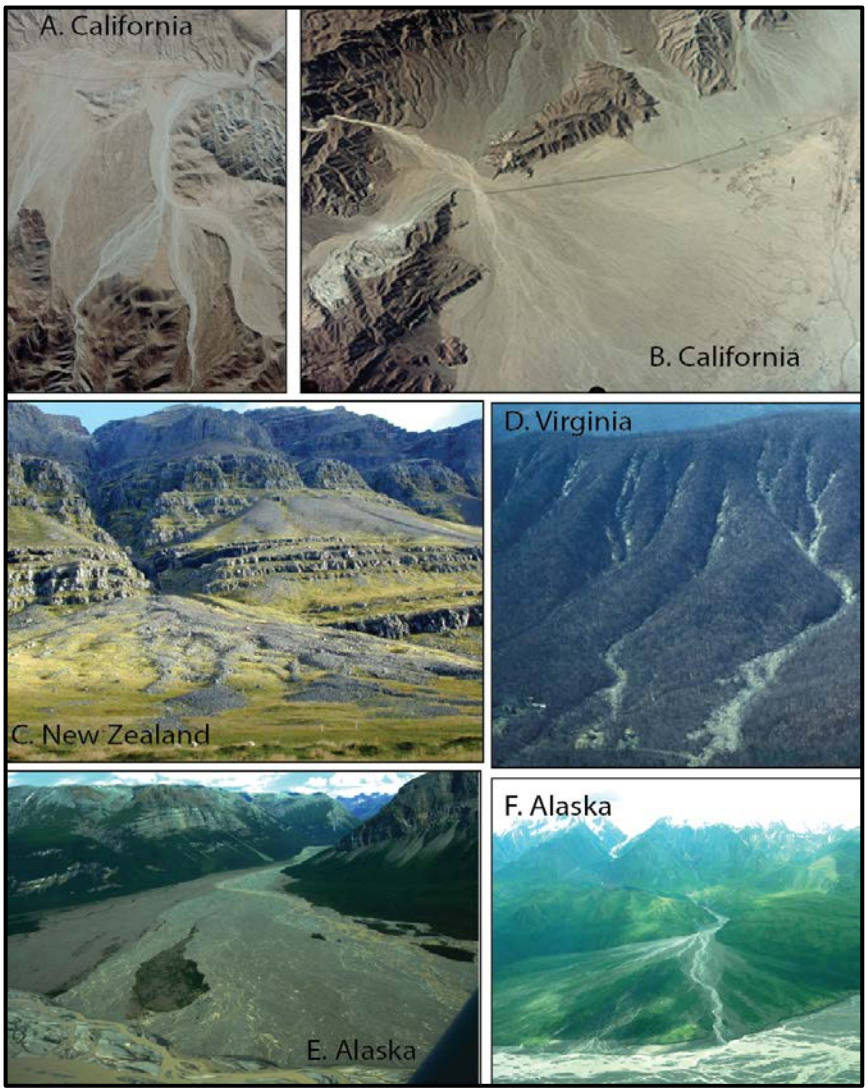


Figure 27. Different types of alluvial fans found around the world. A-B Arid Alluvial fans, C-D. Humid-temperate, debris fans, E-F. Humid glacial fans. Photos A-B are from San Diego County Government, C-F are photos from R. Craig Kochel.

rates) on alluvial fans (Table 9).

CONCLUSIONS

Nine months of icy debris fan observations in the Southern Alps, South Island, New Zealand, Westland National Park have helped aid in the understanding of mass wasting processes, geomorphic responses, and seasonal variations of icy debris fans, and their volume contributions to associated valley glaciers. In rapidly deglaciating alpine regions icy debris fans are evolving alongside the margins of valley glaciers, and are directly related to the decoupling of upper-level icecaps. Nine months of observations of icy debris fans at La Perouse Glacier and Douglas Glacier show the following:

1) Depositional processes are active throughout the year, with ice avalanches being the dominant process (83% at La Perouse Glacier and 98% at Douglas Glacier). The longer monitoring of icy debris fans has recorded 308 mass wasting processes that occurred at La Perouse Glacier and 646 mass wasting depositional events at Douglas Glacier, showing that icy debris fans are persistently active during seasonal changes.

2) Icy debris flows and slushflows only occur following significant rainfall events (Figure 21d.). Additionally, ice avalanches and rockfalls occur after significant rainfall events however, they can also occur anytime. To have an icy debris flow a well-developed catchment needs to be formed therefore, these mass-wasting processes are seen at the La Perouse Glacier site, and are absent at Douglas Glacier site.

3) The cumulative depositional event areas can cover the entire fan area numerous times during a year. Icy debris fans have exceedingly high depositional rates (Table 9), with more than 22 or 30

times the fan surface receiving mass wasting deposits annually. Annual depositional rates on alluvial fans, including stream-dominated and debris-flow dominated fans, are much lower (0-100%, Table 9) than for icy debris fans (598–2,221%, Table 9).

4) The total volume of depositional events on an icy debris fan during one year can exceed the total volume of an icy debris fan itself, emphasizing the dynamic nature of material transfers from the icy debris fans through a combination of ablation and glacial flow into the adjacent valley glacier. Two factors play a major role in the long-term growth of icy debris fans, ablation of ice-rich mass flow deposits with time, and the flow of subsurface ice within icy debris fans into the subjacent valley glacier.

5) During the time period of this study, the icy debris fan volume is 1.6% of the La Perouse Valley Glacier and 4.6% of the Douglas Valley Glacier; this significantly impacts the overall annual ice budget. Annual volumetric ice contribution of icy debris fans to the valley glacier are minimal estimates. The percentages at La Perouse Glacier are different from Douglas Glacier, because the La Perouse Valley Glacier is a larger valley glacier connected to a glacial cirque at the head of the glacier, with only three icy debris fans measured. Douglas Glacier is a smaller valley glacier that is not connected to a glacial cirque, with five icy debris fans measured. The measured volumes of icy debris fans at Douglas Glacier contribute a much larger percentage of material to the total valley glacier volume. This indicates that the five measured Douglas Glacier icy debris fans play a larger role in the annual glacial ice budget than the three icy debris fans measured at La Perouse Glacier.

There are four different mass-wasting processes that occur on an icy debris fan, ice avalanches, icy debris flow, slushflows, and rockfalls. These mass-wasting processes vary with the seasonal variation and catchment morphology. The four mass-wasting processes are active on icy debris fan throughout the year, with fluctuation in different seasons. The rate at which these mass-wasting processes exceed any other type of fan found around the world. Due to this exceedingly high depositional rate the material contribution between the icy debris fan and the underlying glacier is significant. During this time of climate warming icy debris fans have influenced the dynamics of glaciers. It is important to understand the dynamics of glaciers because they play a major role in the Earth's global climatic system. Understanding the mass-wasting processes, geomorphic responses, and seasonal variation of icy debris fans help describe the evolution of valley glaciers therefore, this study will help in understanding the global climatic system.

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APENDIX A. The time-lapse imagery for both La Perouse Glacier and Douglas Glacier can be found attached to the online version located at Bucknell University.

APENDIX B. The complete data set of all the events that occurred on the East Fan and Middle Fan at La Perouse Glacier.

AV: Ice Avalanche

DF: Icy Debris Flow

RF: Rockfall

SF: Slushflow

	East Fan Events					
Date	**AV**	**DF**	**RF**	**SF**	**Total**	**% Area**
1/12/2013	0	0	0	0	0	0
1/13/2013	0	0	0	0	0	0
1/14/2013	0	0	0	0	0	0
1/15/2013	0	0	0	0	0	0
1/16/2013	0	0	0	0	0	0
1/17/2013	0	0	0	0	0	0
1/18/2013	0	0	0	0	0	0
1/19/2013	0	0	0	0	0	0
1/20/2013	1	0	0	0	1	4
1/21/2013	1	0	0	0	1	5
1/22/2013	1	0	0	0	1	4
1/23/2013	0	0	0	0	0	0

1/24/2013	0	0	0	0	0	0
1/25/2013	2	0	0	0	2	5
1/26/2013	2	0	0	0	2	25
1/27/2013	1	0	0	0	1	3
1/28/2013	3	0	0	0	3	9
1/29/2013	0	0	0	0	0	0
1/30/2013	0	0	0	0	0	0
1/31/2013	0	0	0	0	0	0
2/1/2013	0	0	0	0	0	0
2/2/2013	0	0	0	0	0	0
2/3/2013	0	0	0	0	0	0
2/4/2013	0	0	0	0	0	0
2/5/2013	0	0	0	0	0	0
2/6/2013	0	0	0	0	0	0
2/7/2013	0	0	0	0	0	0
2/8/2013	0	0	0	0	0	0
2/9/2013	0	0	0	0	0	0
2/10/2013	0	0	0	0	0	0
2/11/2013	0	0	0	0	0	0
2/12/3013	0	0	0	0	0	0
2/13/2013	0	0	0	0	0	0
2/14/2013	0	0	0	0	0	0
2/15/2013	0	0	0	0	0	0
2/16/2013	0	0	0	0	0	0

2/17/2013	0	0	0	0	0	0
2/18/2013	0	0	0	0	0	0
2/19/2013	0	0	0	0	0	0
2/20/2013	0	0	0	0	0	0
2/21/2013	0	0	0	0	0	0
2/22/2013	0	0	0	0	0	0
2/23/2013	0	0	0	0	0	0
2/24/2013	0	0	0	0	0	0
2/25/2013	0	0	0	0	0	0
2/26/2013	1	0	0	0	1	3
2/27/2013	4	0	0	0	4	21
2/28/2013	0	0	0	0	0	0
3/1/2013	0	0	0	0	0	0
3/2/2013	2	0	0	0	2	15
3/3/2013	0	0	0	0	0	0
3/4/2013	2	0	0	0	2	7
3/5/2013	0	0	0	0	0	0
3/6/2013	2	0	0	0	2	8
3/7/2013	0	0	0	0	0	0
3/8/2013	1	0	0	0	1	5
3/9/2013	2	0	0	0	2	4
3/10/2013	0	0	0	0	0	0
3/11/2013	0	0	0	0	0	0
3/12/2013	0	0	0	0	0	0

3/13/2013	0	0	0	0	0	0
3/14/2013	1	0	0	0	1	4
3/15/2013	0	0	0	0	0	0
3/16/2013	3	0	0	0	3	16
3/17/2013	0	0	0	0	0	0
3/18/2013	0	0	0	0	0	0
3/19/2013	0	0	0	0	0	0
3/20/2013	0	0	0	0	0	0
3/21/2013	0	0	0	0	0	0
3/22/2013	0	0	0	0	0	0
3/23/2013	0	0	0	0	0	0
3/24/2013	0	0	0	0	0	0
3/25/2013	0	0	0	0	0	0
3/26/2013	0	0	0	0	0	0
3/27/2013	0	0	0	0	0	0
3/28/2013	0	0	0	0	0	0
3/29/2013	0	0	0	0	0	0
3/30/2013	0	0	0	0	0	0
3/31/2013	0	0	0	0	0	0
4/1/2013	0	0	0	0	0	0
4/2/2013	0	0	0	0	0	0
4/3/2013	0	0	0	0	0	0
4/4/2013	0	0	0	0	0	0
4/5/2013	0	0	0	0	0	0

4/6/2013	0	0	0	0	0	0
4/7/2013	0	0	0	0	0	0
4/8/2013	0	0	0	0	0	0
4/9/2013	0	0	0	0	0	0
4/10/2013	0	0	0	0	0	0
4/11/2013	2	0	0	0	2	13
4/12/2013	0	0	0	0	0	0
4/13/2013	1	0	0	0	1	12
4/14/2013	0	0	0	0	0	0
4/15/2013	0	0	0	0	0	0
4/16/2013	0	0	0	0	0	0
4/17/2013	0	0	0	0	0	0
4/18/2013	0	0	0	0	0	0
4/19/2013	0	0	0	0	0	0
4/20/2013	0	0	0	0	0	0
4/21/2013	1	0	0	0	1	1
4/22/2013	0	0	0	0	0	0
4/23/2013	0	0	0	0	0	0
4/24/2013	0	0	0	0	0	0
4/25/2013	0	0	0	0	0	0
4/26/2013	0	0	0	0	0	0
4/27/2013	1	0	0	0	1	2
4/28/2013	1	0	0	0	1	4
4/29/2013	0	1	0	0	1	3

4/30/2013	0	0	0	0	0	0
5/1/2013	0	0	0	0	0	0
5/2/2013	0	0	0	0	0	0
5/3/2013	2	0	0	0	2	11
5/4/2013	2	0	0	0	2	5
5/5/2013	0	0	0	0	0	0
5/6/2013	0	0	0	0	0	0
5/7/2013	1	0	0	0	1	8
5/8/2013	1	0	0	0	1	2
5/9/2013	0	0	0	0	0	0
5/10/2013	0	0	0	0	0	0
5/11/2013	0	0	0	0	0	0
5/12/2013	0	0	0	0	0	0
5/13/2013	4	0	0	0	4	19
5/14/2013	2	0	0	0	2	12
5/15/2013	0	0	0	0	0	0
5/16/2013	0	0	0	0	0	0
5/17/2013	2	0	0	0	2	12
5/18/2013	0	0	0	0	0	0
5/19/2013	0	0	0	0	0	0
5/20/2013	0	0	0	0	0	0
5/21/2013	1	0	0	0	1	3
5/22/2013	1	0	0	0	1	5
5/23/2013	1	0	0	0	1	2

5/24/2013	1	0	0	0	1	4
5/25/2013	2	0	0	0	2	9
5/26/2013	2	0	0	0	2	38
5/27/2013	Obscured					
5/28/2013	0	0	0	0	0	0
5/29/2013	0	0	0	0	0	0
5/30/2013	0	0	0	0	0	0
5/31/2013	0	0	0	0	0	0
6/1/2013	1	0	0	0	1	12
6/2/2013	4	0	0	1	5	49
6/3/2013	4	0	0	0	4	44
6/4/2013	0	0	0	0	0	0
6/5/2013	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0
6/7/2013	0	0	0	0	0	0
6/8/2013	0	0	0	0	0	0
6/9/2013	0	0	0	0	0	0
6/10/2013	0	0	0	0	0	0
6/11/2013	0	0	0	0	0	0
6/12/2013	2	0	0	0	2	17
6/13/2013	0	0	0	0	0	0
6/14/2013	0	0	0	0	0	0
6/15/2013	1	0	0	0	1	2
6/16/2013	1	0	0	0	1	3

6/17/2013	0	0	0	0	0	0
6/18/2013	0	0	0	0	0	0
6/19/2013	0	0	0	0	0	0
6/20/2013	0	0	0	0	0	0
6/21/2013	0	0	0	0	0	0
6/22/2013	0	0	0	0	0	0
6/23/2013	0	0	0	0	0	0
6/24/2013	0	0	0	0	0	0
6/25/3013	0	0	0	0	0	0
6/26/2013	0	0	0	0	0	0
6/27/2013	0	0	0	0	0	0
6/28/2013	0	0	0	0	0	0
6/29/2013	0	0	0	0	0	0
6/30/2013	0	0	0	0	0	0
7/1/2013	0	0	0	0	0	0
7/2/2013	3	0	0	0	3	60
7/3/2013	3	0	0	0	3	55
7/4/2013	0	0	0	0	0	0
7/5/2013	0	0	0	0	0	
7/6/2013	1	0	0	0	1	12
7/7/2013	0	0	0	0	0	0
7/8/2013	0	0	0	0	0	0
7/9/2013	0	0	0	0	0	0
7/10/2013	0	0	0	0	0	0

7/11/2013	0	0	0	0	0	0
7/12/2013	0	0	0	0	0	0
7/13/2013	Obscured					
7/14/2013	Obscured					
7/15/2013	Obscured					
7/16/2013	Obscured					
7/17/2013	Obscured					
7/18/2013	0	0	0	0	0	0
7/19/2013	0	0	0	0	0	0
7/20/2013	0	0	0	0	0	0
7/21/2013	0	0	0	0	0	0
7/22/2013	0	0	0	0	0	0
7/23/2013	Obscured					
7/24/2013	Obscured					
7/25/2013	Obscured					
7/26/2013	Obscured					
7/27/2013	Obscured					
7/28/2013	0	0	0	0	0	0
7/29/2013	Obscured					
7/30/2013	Obscured					
7/31/2013	Obscured					
8/1/2013	Obscured					
8/2/2013	0	0	0	0	0	0
8/3/2013	0	0	0	0	0	0

8/4/2013	1	0	0	0	1	8
8/5/2013	1	0	0	0	1	10
8/6/2013	0	0	0	0	0	0
8/7/2013	1	0	0	0	1	20
8/8/2013	0	0	0	0	0	0
8/9/2013	0	0	0	0	0	0
8/10/2013	0	0	0	0	0	0
8/11/2013	0	0	0	0	0	0
8/12/2013	0	0	0	0	0	0
8/13/2013	0	0	0	0	0	0
8/14/2013	0	0	0	0	0	0
8/15/2013	0	0	0	0	0	0
8/16/2013	1	0	0	0	1	20
8/17/2013	0	0	0	0	0	0
8/18/2013	1	0	0	0	1	23
8/19/2013	0	0	0	0	0	0
8/20/2013	0	0	0	0	0	0
8/21/2013	1	0	0	0	1	16
8/22/2013	0.0	0.0	0.0	0.0	0	0.0
8/23/2013	Obscured					
8/24/2013	Obscured					
8/25/2013	Obscured					
8/26/2013	Obscured					
8/27/2013	Obscured					

8/28/2013	0	0	0	0	0	0
8/29/2013	0	0	0	0	0	0
8/30/2013	0	0	0	0	0	0
8/31/2013	0	0	0	0	0	0
9/1/2013	0	0	0	0	0	0
9/2/2013	0	0	0	0	0	0
9/3/2013	0	0	0	0	0	0
9/4/2013	Obscured					
9/5/2013	Obscured					
9/6/2013	0	0	0	0	0	0
9/7/2013	0.0	0.0	0.0	0.0	0	0.0
9/8/2013	0	0	0	0	0	0
9/9/2013	Obscured					
9/10/2013	Obscured					
9/11/2013	Obscured					
9/12/2013	Obscured					
9/13/2013	Obscured					

AV: Ice Avalanche

DF: Icy Debris Flow

RF: Rockfall

SF: Slushflow

	Middle Fan Events					
Date	**AV**	**DF**	**RF**	**SF**	**Total**	**% Area**
1/12/2013	2	0	0	0	2	32
1/13/2013	4	0	0	1	5	58
1/14/2013	0	0	0	0	0	0
1/15/2013	0	0	0	0	0	0
1/16/2013	0	0	0	0	0	0
1/17/2013	5	0	0	0	5	57
1/18/2013	0	0	0	0	0	0
1/19/2013	0	0	0	0	0	0
1/20/2013	0	0	0	0	0	0
1/21/2013	0	0	0	0	0	0
1/22/2013	0	0	0	0	0	0
1/23/2013	0	0	0	0	0	0
1/24/2013	0	0	0	0	0	0
1/25/2013	1	0	0	0	1	11
1/26/2013	0	0	0	0	0	0
1/27/2013	2	0	0	0	2	16
1/28/2013	0	0	0	0	0	0
1/29/2013	0	0	0	0	0	0
1/30/2013	0	0	0	0	0	0
1/31/2013	2	0	0	0	2	21
2/1/2013	4	0	0	0	4	49
2/2/2013	0	0	0	0	0	0
2/3/2013	4	0	0	0	4	19
2/4/2013	1	1	0	0	2	19
2/5/2013	1	0	0	0	1	5
2/6/2013	6	0	0	0	6	62
2/7/2013	2	0	0	0	2	5
2/8/2013	3	0	0	0	3	18
2/9/2013	0	0	0	0	0	0
2/10/2013	0	0	0	0	0	0
2/11/2013	0	0	0	0	0	0
2/12/3013	3	0	0	0	3	25
2/13/2013	0	0	0	0	0	0

2/14/2013	1	0	0	0	1	7
2/15/2013	0	0	0	0	0	0
2/16/2013	0	0	0	0	0	0
2/17/2013	4	0	0	0	4	16
2/18/2013	3	0	0	0	3	27
2/19/2013	1	0	0	0	1	25
2/20/2013	0	0	0	0	0	0
2/21/2013	0	0	0	0	0	0
2/22/2013	0	0	0	0	0	0
2/23/2013	0	0	0	0	0	0
2/24/2013	0	0	0	0	0	0
2/25/2013	2	0	0	0	2	7
2/26/2013	0	0	0	0	0	0
2/27/2013	5	0	0	0	5	24
2/28/2013	0	0	0	0	0	0
3/1/2013	4	0	0	0	4	55
3/2/2013	2	0	0	0	2	20
3/3/2013	0	0	0	0	0	0
3/4/2013	0	0	0	0	0	0
3/5/2013	0	0	0	0	0	0
3/6/2013	1	0	0	0	1	2
3/7/2013	0	0	0	0	0	0
3/8/2013	0	0	0	0	0	0
3/9/2013	0	0	0	0	0	0
3/10/2013	1	0	0	0	1	3
3/11/2013	3	0	0	0	3	19
3/12/2013	2	0	0	0	2	27
3/13/2013	0	0	0	0	0	0
3/14/2013	0	0	0	0	0	0
3/15/2013	0	0	0	0	0	0
3/16/2013	0	0	0	0	0	0
3/17/2013	2	0	0	0	2	13
3/18/2013	0	3	0	0	3	33
3/19/2013	0	0	0	0	0	0
3/20/2013	0	0	0	0	0	0
3/21/2013	0	0	0	0	0	0
3/22/2013	0	0	0	0	0	0
3/23/2013	2	0	0	0	2	30
3/24/2013	0	0	0	0	0	0
3/25/2013	0	0	0	0	0	0
3/26/2013	0	0	0	0	0	0

3/27/2013	0	0	0	0	0	0
3/28/2013	0	0	0	0	0	0
3/29/2013	0	0	0	0	0	0
3/30/2013	0	0	0	0	0	0
3/31/2013	7	0	0	0	7	53
4/1/2013	5	0	0	0	5	68
4/2/2013	5	0	0	0	5	39
4/3/2013	0	0	0	0	0	0
4/4/2013	0	0	0	0	0	0
4/5/2013	1	0	0	0	1	10
4/6/2013	0	0	0	0	0	0
4/7/2013	0	0	0	0	0	0
4/8/2013	0	0	0	0	0	0
4/9/2013	0	0	0	0	0	0
4/10/2013	0	0	0	0	0	0
4/11/2013	0	0	0	0	0	0
4/12/2013	0	0	0	0	0	0
4/13/2013	0	0	0	0	0	0
4/14/2013	1	0	0	0	1	7
4/15/2013	0	0	0	0	0	0
4/16/2013	3	0	0	0	3	26
4/17/2013	0	0	0	0	0	0
4/18/2013	0	0	0	0	0	0
4/19/2013	0	0	0	0	0	0
4/20/2013	0	0	0	0	0	0
4/21/2013	0	0	0	0	0	0
4/22/2013	1	0	0	0	1	4
4/23/2013	1	0	0	0	1	5
4/24/2013	2	0	0	0	2	22
4/25/2013	0	0	1	0	1	1
4/26/2013	1	0	0	0	1	10
4/27/2013	0	2	0	0	2	3
4/28/2013	1	0	0	0	1	4
4/29/2013	0	4	0	0	4	8
4/30/2013	0	0	0	0	0	0
5/1/2013	0	0	0	0	0	0
5/2/2013	2	0	0	0	2	6
5/3/2013	3	0	0	0	3	16
5/4/2013	0	0	0	0	0	0
5/5/2013	0	0	0	0	0	0
5/6/2013	0	0	0	0	0	0

5/7/2013	4	0	0	0	4	25
5/8/2013	0	0	0	0	0	0
5/9/2013	3	0	0	0	3	17
5/10/2013	2	0	0	0	2	12
5/11/2013	5	0	0	0	5	31
5/12/2013	2	0	0	0	2	10
5/13/2013	0	0	0	0	0	0
5/14/2013	1	0	0	0	1	18
5/15/2013	4	0	0	0	4	41
5/16/2013	0	0	0	0	0	0
5/17/2013	0	0	0	0	0	0
5/18/2013	0	0	0	0	0	0
5/19/2013	0	0	0	0	0	0
5/20/2013	0	0	0	0	0	0
5/21/2013	0	0	0	0	0	0
5/22/2013	0	0	0	0	0	0
5/23/2013	0	0	0	0	0	0
5/24/2013	0	0	0	0	0	0
5/25/2013	0	0	0	0	0	0
5/26/2013	3	0	0	0	3	46
5/27/2013	Obscured					
5/28/2013	1	0	0	0	1	14
5/29/2013	0	0	0	0	0	0
5/30/2013	0	0	0	0	0	0
5/31/2013	0	0	0	0	0	0
6/1/2013	0	0	0	0	0	0
6/2/2013	0	0	0	0	0	0
6/3/2013	0	4	0	3	7	29
6/4/2013	0	0	0	1	1	4
6/5/2013	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0
6/7/2013	0	0	0	0	0	0
6/8/2013	0	0	0	0	0	0
6/9/2013	0	0	0	0	0	0
6/10/2013	5	0	0	0	5	50
6/11/2013	2	0	0	0	2	23
6/12/2013	0	0	0	0	0	0
6/13/2013	1	0	0	0	1	11
6/14/2013	1	0	0	0	1	13
6/15/2013	0	0	0	0	0	0
6/16/2013	1	0	0	0	1	15

6/17/2013	6	0	0	0	6	79
6/18/2013	1	0	0	0	1	11
6/19/2013	0	0	0	0	0	0
6/20/2013	0	0	0	0	0	0
6/21/2013	0	0	0	0	0	0
6/22/2013	0	0	0	0	0	0
6/23/2013	0	0	0	0	0	0
6/24/2013	0	0	0	0	0	0
6/25/3013	0	0	0	0	0	0
6/26/2013	0	0	0	0	0	0
6/27/2013	0	0	0	0	0	0
6/28/2013	0	0	0	0	0	0
6/29/2013	0	0	0	0	0	0
6/30/2013	0	0	0	0	0	0
7/1/2013	0	0	0	0	0	0
7/2/2013	2	0	0	0	2	12
7/3/2013	2	0	0	0	2	8
7/4/2013	1	0	0	0	1	8
7/5/2013	0	0	0	0	0	0
7/6/2013	0	0	0	0	0	0
7/7/2013	0	0	0	0	0	0
7/8/2013	0	0	0	0	0	0
7/9/2013	0	0	0	0	0	0
7/10/2013	0	0	0	0	0	0
7/11/2013	0	0	0	0	0	0
7/12/2013	0	0	0	1	1	5
7/13/2013	Obscured					
7/14/2013	Obscured					
7/15/2013	Obscured					
7/16/2013	Obscured					
7/17/2013	Obscured					
7/18/2013	7	0	0	0	7	54
7/19/2013	0	0	0	0	0	0
7/20/2013	0	0	0	0	0	0
7/21/2013	0	0	0	0	0	0
7/22/2013	3	0	0	0	3	39
7/23/2013	Obscured					
7/24/2013	Obscured					
7/25/2013	Obscured					
7/26/2013	Obscured					
7/27/2013	Obscured					

7/28/2013	1	0	0	0	1	10
7/29/2013	Obscured					
7/30/2013	Obscured					
7/31/2013	Obscured					
8/1/2013	Obscured					
8/2/2013	6	0	0	0	6	60
8/3/2013	0	0	0	0	0	0
8/4/2013	0	0	0	0	0	0
8/5/2013	1	0	0	0	1	4
8/6/2013	0	0	0	0	0	0
8/7/2013	0	0	0	0	0	0
8/8/2013	0	0	0	0	0	0
8/9/2013	0	0	0	0	0	0
8/10/2013	4	0	0	0	4	21
8/11/2013	6	0	0	0	6	65
8/12/2013	0	0	0	0	0	0
8/13/2013	0	0	0	0	0	0
8/14/2013	0	0	0	0	0	0
8/15/2013	0	0	0	0	0	0
8/16/2013	4	0	0	0	4	19
8/17/2013	0	0	0	0	0	0
8/18/2013	0	0	0	1	1	12
8/19/2013	0	0	0	1	1	5
8/20/2013	0	0	0	1	1	2
8/21/2013	0	0	0	0	0	23
8/22/2013	0	0	0	0	0	0
8/23/2013	Obscured					
8/24/2013	Obscured					
8/25/2013	Obscured					
8/26/2013	Obscured					
8/27/2013	Obscured					
8/28/2013	2	0	0	0	2	48
8/29/2013	2	0	0	0	2	12
8/30/2013	0	0	0	0	0	0
8/31/2013	0	0	0	0	0	0
9/1/2013	1	0	0	0	1	10
9/2/2013	0	0	0	0	0	0
9/3/2013	2	0	0	0	2	25
9/4/2013	Obscured					
9/5/2013	Obscured					
9/6/2013	0	0	0	0	0	0

9/7/2013	2	0	0	0	2	40
9/8/2013	0	0	0	0	0	0
9/9/2013	Obscured					
9/10/2013	Obscured					
9/11/2013	Obscured					
9/12/2013	Obscured					
9/13/2013	Obscured					

APPENDIX C. The complete data set of all the events that occurred on the East Fan and Middle Fan at La Perouse Glacier.

AV: Ice Avalanche

DF: Icy Debris Flow

RF: Rockfall

SF: Slushflow

	Fan 1 Events at Douglas Glacier					
Date	**AV**	**DF**	**RF**	**SF**	**Tot**	**Ar1**
1/7/2013	0	0	0	0	0	0
1/8/2013	0	0	0	0	0	0
1/9/2013	1	0	0	0	1	15
1/10/2013	2	0	0	0	2	19
1/11/2013	1	0	0	0	1	7
1/12/2013	3	0	0	0	3	21
1/13/2013	0	0	0	0	0	0
1/14/2013	0	0	0	0	0	0
1/15/2013	1	0	0	0	1	18
1/16/2013	0	0	0	0	0	0
1/17/2013	1	0	0	0	1	10
1/18/2013	1	0	0	0	1	25
1/19/2013	1	0	0	0	1	20
1/20/2013	0	0	0	0	0	0
1/21/2013	1	0	0	0	1	21
1/22/2013	2	0	0	0	2	21
1/23/2013	2	0	0	0	2	10
1/24/2013	0	0	0	0	0	0
1/25/2013	1	0	0	0	1	5

1/26/2013	0	0	0	0	0	0
1/27/2013	1	0	0	0	1	8
1/28/2013	0	0	0	0	0	0
1/29/2013	0	0	0	0	0	0
1/30/2013	0	0	0	0	0	0
1/31/2013	0	0	0	0	0	0
2/1/2013	0	0	0	0	0	0
2/2/2013	0	0	0	0	0	0
2/3/2013	0	0	0	0	0	0
2/4/2013	0	0	0	0	0	0
2/5/2013	0	0	0	0	0	0
2/6/2013	0	0	0	0	0	0
2/7/2013	0	0	0	0	0	0
2/8/2013	0	0	0	0	0	0
2/9/2013	0	0	0	0	0	0
2/10/2013	0	0	0	0	0	0
2/11/2013	0	0	0	0	0	0
2/12/3013	1	0	0	0	1	3
2/13/2013	1	0	0	0	1	1
2/14/2013	0	0	0	0	0	0
2/15/2013	0	0	0	0	0	0
2/16/2013	2	0	0	0	2	78
2/17/2013	0	0	0	0	0	0
2/18/2013	0	0	0	0	0	0
2/19/2013	0	0	0	0	0	0
2/20/2013	0	0	0	0	0	0
2/21/2013	0	0	0	0	0	0
2/22/2013	0	0	0	0	0	0
2/23/2013	0	0	0	0	0	0
2/24/2013	0	0	0	0	0	0
2/25/2013	0	0	0	0	0	0
2/26/2013	0	0	0	0	0	0
2/27/2013	0	0	0	0	0	0
2/28/2013	0	0	0	0	0	0
3/1/2013	0	0	0	0	0	0
3/2/2013	0	0	0	0	0	0
3/3/2013	0	0	0	0	0	0
3/4/2013	1	0	0	0	1	2
3/5/2013	3	0	0	0	3	43
3/6/2013	0	0	0	0	0	0
3/7/2013	0	0	0	0	0	0

3/8/2013	1	0	0	0	1	2
3/9/2013	0	0	0	0	0	0
3/10/2013	0	0	0	0	0	0
3/11/2013	1	0	0	0	1	2
3/12/2013	1	0	0	0	1	2
3/13/2013	2	0	0	0	2	14
3/14/2013	0	0	0	0	0	0
3/15/2013	0	0	0	0	0	0
3/16/2013	4	0	0	0	4	17
3/17/2013	0	0	0	0	0	0
3/18/2013	0	0	0	0	0	0
3/19/2013	1	0	0	0	1	1
3/20/2013	0	0	0	0	0	0
3/21/2013	0	0	0	0	0	0
3/22/2013	5	0	0	0	5	20
3/23/2013	0	0	0	0	0	0
3/24/2013	0	0	0	0	0	0
3/25/3013	0	0	0	0	0	0
3/26/2013	0	0	0	0	0	0
3/27/2013	0	0	0	0	0	0
3/28/2013	0	0	0	0	0	0
3/29/2013	0	0	0	0	0	0
3/30/2013	0	0	0	0	0	0
3/31/2013	0	0	0	0	0	0
4/1/2013	0	0	0	0	0	0
4/2/2013	0	0	0	0	0	0
4/3/2013	0	0	0	0	0	0
4/4/2013	0	0	0	0	0	0
4/5/2013	0	0	0	0	0	0
4/6/2013	0	0	0	0	0	0
4/7/2013	2	0	0	0	2	8
4/8/2013	1	0	0	0	1	7
4/9/2013	0	0	0	0	0	0
4/10/2013	0	0	0	0	0	0
4/11/2013	0	0	0	0	0	0
4/12/2013	0	0	0	0	0	0
4/13/2013	0	0	0	0	0	0
4/14/2013	1	0	0	0	1	5
4/15/2013	0	0	0	0	0	0
4/16/2013	3	0	0	0	3	8
4/17/2013	0	0	0	0	0	0

4/18/2013	0	0	0	0	0	0
4/19/2013	0	0	0	0	0	0
4/20/2013	1	0	0	0	1	5
4/21/2013	0	0	0	0	0	0
4/22/2013	0	0	0	0	0	0
4/23/2013	0	0	0	0	0	0
4/24/2013	3	0	0	0	3	15
4/25/2013	0	0	0	0	0	0
4/26/2013	2	0	0	0	2	4
4/27/2013	1	0	0	0	1	5
4/28/2013	2	0	0	0	2	10
4/29/2014	1	0	0	0	1	8
4/30/2014	1	0	0	0	1	1
5/1/2013	2	0	0	0	2	4
5/2/2013	0	0	0	0	0	0
5/3/2013	2	0	0	0	2	11
5/4/2013	1	0	0	0	1	2
5/5/2013	3	0	0	0	3	33
5/6/2013	3	0	0	0	3	49
5/7/2013	0	0	0	0	0	0
5/8/2013	1	0	0	0	1	5
5/9/2013	0	0	0	0	0	0
5/10/2013	0	0	0	0	0	0
5/11/2013	1	0	0	0	1	3
5/12/2013	1	0	0	0	1	2
5/13/2013	1	0	0	0	1	12
5/14/2013	5	0	0	0	5	45
5/15/2013	0	0	0	0	0	0
5/16/2013	2	0	0	0	2	89
5/17/2013	0	0	0	0	0	0
5/18/2013	0	0	0	0	0	0
5/19/2013	2	0	0	0	2	11
5/20/2013	1	0	0	0	1	5
5/21/2013	0	0	0	0	0	0
5/22/2013	0	0	0	0	0	0
5/23/2013	0	0	0	0	0	0
5/24/2013	0	0	0	0	0	0
5/25/2013	0	0	0	0	0	0
5/26/2013	0	0	0	0	0	0
5/27/2013	0	0	0	0	0	0
5/28/2013	0	0	0	0	0	0

5/29/2013	0	0	0	0	0	0
5/30/2013	0	0	0	0	0	0
5/31/2013	0	0	0	0	0	0
6/1/2013	0	0	0	0	0	0
6/2/2013	0	0	0	0	0	0
6/3/2013	0	0	0	0	0	0
6/4/2013	0	0	0	0	0	0
6/5/2013	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0
6/7/2013	0	0	0	0	0	0
6/8/2013	0	0	0	0	0	0
6/9/2013	0	0	0	0	0	0
6/10/2013	1	0	0	0	1	6
6/11/2013	1	0	0	0	1	2
6/12/2013	2	0	0	0	2	8
6/13/2013	2	0	0	0	2	7
6/14/2013	0	0	0	0	0	0
6/15/2013	0	0	0	0	0	0
6/16/2013	0	0	0	0	0	0
6/17/2013	0	0	0	0	0	0
6/18/2013	3	0	0	0	3	21
6/19/2013	0	0	0	0	0	0
6/20/2013	0	0	0	0	0	0
6/21/2013	0	0	0	0	0	0
6/22/2013	0	0	0	0	0	0
6/23/2013	0	0	0	0	0	0
6/24/2013	1	0	0	0	1	12
6/25/2013	0	0	0	0	0	0
6/26/2013	0	0	0	0	0	0
6/27/2013	0	0	0	0	0	0
6/28/2013	0	0	0	0	0	0
6/29/2013	0	0	0	0	0	0
6/30/2013	0	0	0	0	0	0
7/1/2013	0	0	0	0	0	0
7/2/2013	0	0	0	0	0	0
7/3/2013	0	0	0	0	0	0
7/4/2013	0	0	0	0	0	0
7/5/2014	0	0	0	0	0	0
7/6/2013	0	0	0	0	0	0
7/7/2013	0	0	0	0	0	0
7/8/2013	0	0	0	0	0	0

7/9/2013	0	0	0	0	0	0
7/10/2013	0	0	0	1	1	5
7/11/2013	0	0	0	0	0	0
7/12/2013	0	0	0	0	0	0
7/13/2013	0	0	0	0	0	0
7/14/2013	0	0	0	0	0	0
7/15/2013	0	0	0	0	0	0
7/16/2013	0	0	0	0	0	0
7/17/2013	0	0	0	0	0	0
7/18/2013	0	0	0	0	0	0
7/19/2013	3	0	0	0	3	63
7/20/2013	2	0	0	0	2	16
7/21/2013	0	0	0	0	0	50
7/22/2013	0	0	0	0	0	0
7/23/2013	0	0	0	0	0	0
7/24/2013	0	0	0	0	0	0
7/25/2013	0	0	0	0	0	0
7/26/2013	0	0	0	0	0	0
7/27/2013	0	0	0	0	0	0
7/28/2013	0	0	0	0	0	0
7/29/2013	0	0	0	0	0	0
7/30/2013	0	0	0	0	0	0
7/31/2013	0	0	0	0	0	0
8/1/2013	0	0	0	0	0	0
8/2/2013	0	0	0	0	0	0
8/3/2013	0	0	0	0	0	0
8/4/2013	0	0	0	0	0	0
8/5/2013	0	0	0	0	0	0
8/6/2013	0	0	0	0	0	0
8/7/2013	1	0	0	0	1	100
8/8/2013	0	0	0	0	0	0
8/9/2013	1	0	0	0	1	30
8/10/2013	0	0	0	0	0	0
8/11/2013	0	0	0	0	0	0
8/12/2013	0	0	0	0	0	0
8/13/2013	0	0	0	0	0	0
8/14/2013	0	0	0	0	0	0
8/15/2013	0	0	0	0	0	0
8/16/2013	0	0	0	0	0	0
8/17/2013	0	0	0	0	0	0
8/18/2013	0	0	0	0	0	0

8/19/2013	1	0	0	0	1	60
8/20/2013	0	0	0	0	0	0
8/21/2013	0	0	0	0	0	0
8/22/2013	0	0	0	0	0	0

AV: Ice Avalanche

DF: Icy Debris Flow

RF: Rockfall

SF: Slushflow

	Fan 2 Events at Douglas Glacier					
Date	**AV**	**DF**	**RF**	**SF**	**Tot**	**Ar2**
1/7/2013	0	0	0	0	0	0
1/8/2013	1	0	0	0	1	15
1/9/2013	1	0	0	0	1	20
1/10/2013	0	0	0	0	0	0
1/11/2013	0	0	0	0	0	0
1/12/2013	0	0	0	0	0	0
1/13/2013	0	0	0	0	0	0
1/14/2013	0	0	0	0	0	0
1/15/2013	1	0	0	0	1	5
1/16/2013	1	0	0	0	1	9
1/17/2013	0	0	0	0	0	0
1/18/2013	1	0	0	0	1	40
1/19/2013	0	0	0	0	0	0
1/20/2013	0	0	0	0	0	0
1/21/2013	0	0	0	0	0	0
1/22/2013	0	0	0	0	0	0
1/23/2013	2	0	0	0	2	64
1/24/2013	0	0	0	0	0	0
1/25/2013	0	0	0	0	0	0
1/26/2013	0	0	0	0	0	0
1/27/2013	0	0	0	0	0	0
1/28/2013	0	0	0	0	0	0
1/29/2013	0	0	0	0	0	0
1/30/2013	0	0	0	0	0	0
1/31/2013	1	0	0	0	1	12

2/1/2013	0	0	0	0	0	0
2/2/2013	1	0	0	0	1	50
2/3/2013	0	0	0	0	0	0
2/4/2013	0	0	0	0	0	0
2/5/2013	1	0	0	0	1	5
2/6/2013	0	0	0	0	0	0
2/7/2013	0	0	0	0	0	0
2/8/2013	0	0	0	0	0	0
2/9/2013	0	0	0	0	0	0
2/10/2013	0	0	0	0	0	0
2/11/2013	0	0	0	0	0	0
2/12/3013	1	0	0	0	1	5
2/13/2013	0	0	0	0	0	0
2/14/2013	0	0	0	0	0	0
2/15/2013	0	0	0	0	0	0
2/16/2013	0	0	0	0	0	0
2/17/2013	0	0	0	0	0	0
2/18/2013	0	0	0	0	0	0
2/19/2013	0	0	0	0	0	0
2/20/2013	0	0	0	0	0	0
2/21/2013	0	0	0	0	0	0
2/22/2013	0	0	0	0	0	0
2/23/2013	0	0	0	0	0	0
2/24/2013	0	0	0	0	0	0
2/25/2013	0	0	0	0	0	0
2/26/2013	0	0	0	0	0	0
2/27/2013	0	0	0	0	0	0
2/28/2013	0	0	0	0	0	0
3/1/2013	0	0	0	0	0	0
3/2/2013	0	0	0	0	0	0
3/3/2013	0	0	0	0	0	0
3/4/2013	1	0	0	0	1	3
3/5/2013	0	0	0	0	0	0
3/6/2013	0	0	0	0	0	0
3/7/2013	0	0	0	0	0	0
3/8/2013	0	0	0	0	0	0
3/9/2013	0	0	0	0	0	0
3/10/2013	0	0	0	0	0	0
3/11/2013	0	0	0	0	0	0
3/12/2013	0	0	0	0	0	0
3/13/2013	0	0	0	0	0	0

3/14/2013	0	0	0	0	0	0
3/15/2013	0	0	0	0	0	0
3/16/2013	0	0	0	0	0	0
3/17/2013	0	0	0	0	0	0
3/18/2013	0	0	0	0	0	0
3/19/2013	0	0	0	0	0	0
3/20/2013	0	0	0	0	0	0
3/21/2013	0	0	0	0	0	0
3/22/2013	0	0	0	0	0	0
3/23/2013	0	0	0	0	0	0
3/24/2013	3	0	0	0	3	85
3/25/3013	0	0	0	0	0	0
3/26/2013	0	0	0	0	0	0
3/27/2013	0	0	0	0	0	0
3/28/2013	0	0	0	0	0	0
3/29/2013	0	0	0	0	0	0
3/30/2013	0	0	0	0	0	0
3/31/2013	0	0	0	0	0	0
4/1/2013	0	0	0	0	0	0
4/2/2013	0	0	0	0	0	0
4/3/2013	0	0	0	0	0	0
4/4/2013	0	0	0	0	0	0
4/5/2013	0	0	0	0	0	0
4/6/2013	0	0	0	0	0	0
4/7/2013	0	0	0	0	0	0
4/8/2013	0	0	0	0	0	0
4/9/2013	0	0	0	0	0	0
4/10/2013	0	0	0	0	0	0
4/11/2013	0	0	0	0	0	0
4/12/2013	0	0	0	0	0	0
4/13/2013	0	0	0	0	0	0
4/14/2013	0	0	0	0	0	0
4/15/2013	0	0	0	0	0	0
4/16/2013	0	0	0	0	0	0
4/17/2013	0	0	0	0	0	0
4/18/2013	0	0	0	0	0	0
4/19/2013	0	0	0	0	0	0
4/20/2013	0	0	0	0	0	0
4/21/2013	0	0	0	0	0	0
4/22/2013	0	0	0	0	0	0
4/23/2013	0	0	0	0	0	0

4/24/2013	0	0	0	0	0	0
4/25/2013	0	0	0	0	0	0
4/26/2013	0	0	0	0	0	0
4/27/2013	0	0	0	0	0	0
4/28/2013	0	0	0	0	0	0
4/29/2014	0	0	0	0	0	0
4/30/2014	0	0	0	0	0	0
5/1/2013	0	0	0	0	0	0
5/2/2013	0	0	0	0	0	0
5/3/2013	0	0	0	0	0	0
5/4/2013	0	0	0	0	0	0
5/5/2013	0	0	0	0	0	0
5/6/2013	0	0	0	0	0	0
5/7/2013	0	0	0	0	0	0
5/8/2013	0	0	0	0	0	0
5/9/2013	0	0	0	0	0	0
5/10/2013	0	0	0	0	0	0
5/11/2013	0	0	0	0	0	0
5/12/2013	0	0	0	0	0	0
5/13/2013	0	0	0	0	0	0
5/14/2013	0	0	0	0	0	0
5/15/2013	0	0	0	0	0	0
5/16/2013	0	0	0	0	0	0
5/17/2013	0	0	0	0	0	0
5/18/2013	0	0	0	0	0	0
5/19/2013	0	0	0	0	0	0
5/20/2013	0	0	0	0	0	0
5/21/2013	0	0	0	0	0	0
5/22/2013	0	0	0	0	0	0
5/23/2013	0	0	0	0	0	0
5/24/2013	0	0	0	0	0	0
5/25/2013	0	0	0	0	0	0
5/26/2013	0	0	0	0	0	0
5/27/2013	0	0	0	0	0	0
5/28/2013	0	0	0	0	0	0
5/29/2013	0	0	0	0	0	0
5/30/2013	0	0	0	0	0	0
5/31/2013	0	0	0	0	0	0
6/1/2013	0	0	0	0	0	0
6/2/2013	0	0	0	0	0	0
6/3/2013	0	0	0	0	0	0

6/4/2013	0	0	0	0	0	0
6/5/2013	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0
6/7/2013	0	0	0	0	0	0
6/8/2013	0	0	0	0	0	0
6/9/2013	0	0	0	0	0	0
6/10/2013	0	0	0	0	0	0
6/11/2013	0	0	0	0	0	0
6/12/2013	0	0	0	0	0	0
6/13/2013	0	0	0	0	0	0
6/14/2013	0	0	0	0	0	0
6/15/2013	0	0	0	0	0	0
6/16/2013	0	0	0	0	0	0
6/17/2013	0	0	0	0	0	0
6/18/2013	0	0	0	0	0	0
6/19/2013	0	0	0	0	0	0
6/20/2013	0	0	0	0	0	0
6/21/2013	0	0	0	0	0	0
6/22/2013	0	0	0	0	0	0
6/23/2013	0	0	0	0	0	0
6/24/2013	0	0	0	0	0	0
6/25/2013	0	0	0	0	0	0
6/26/2013	0	0	0	0	0	0
6/27/2013	0	0	0	0	0	0
6/28/2013	0	0	0	0	0	0
6/29/2013	0	0	0	0	0	0
6/30/2013	0	0	0	0	0	0
7/1/2013	0	0	0	0	0	0
7/2/2013	0	0	0	0	0	0
7/3/2013	0	0	0	0	0	0
7/4/2013	0	0	0	0	0	0
7/5/2014	0	0	0	0	0	0
7/6/2013	0	0	0	0	0	0
7/7/2013	0	0	0	0	0	0
7/8/2013	0	0	0	0	0	0
7/9/2013	0	0	0	0	0	0
7/10/2013	0	0	0	0	0	0
7/11/2013	0	0	0	0	0	0
7/12/2013	0	0	0	0	0	0
7/13/2013	0	0	0	0	0	0
7/14/2013	0	0	0	0	0	0

7/15/2013	0	0	0	0	0	0
7/16/2013	0	0	0	0	0	0
7/17/2013	0	0	0	0	0	0
7/18/2013	0	0	0	0	0	0
7/19/2013	0	0	0	0	0	0
7/20/2013	0	0	0	0	0	0
7/21/2013	0	0	0	0	0	0
7/22/2013	0	0	0	0	0	0
7/23/2013	0	0	0	0	0	0
7/24/2013	0	0	0	0	0	0
7/25/2013	0	0	0	0	0	0
7/26/2013	0	0	0	0	0	0
7/27/2013	0	0	0	0	0	0
7/28/2013	0	0	0	0	0	0
7/29/2013	0	0	0	0	0	0
7/30/2013	0	0	0	0	0	0
7/31/2013	0	0	0	0	0	0
8/1/2013	0	0	0	0	0	0
8/2/2013	0	0	0	0	0	0
8/3/2013	0	0	0	0	0	0
8/4/2013	0	0	0	0	0	0
8/5/2013	0	0	0	0	0	0
8/6/2013	0	0	0	0	0	0
8/7/2013	0	0	0	0	0	0
8/8/2013	0	0	0	0	0	0
8/9/2013	0	0	0	0	0	0
8/10/2013	0	0	0	0	0	0
8/11/2013	0	0	0	0	0	0
8/12/2013	0	0	0	0	0	0
8/13/2013	0	0	0	0	0	0
8/14/2013	0	0	0	0	0	0
8/15/2013	0	0	0	0	0	0
8/16/2013	0	0	0	0	0	0
8/17/2013	0	0	0	0	0	0
8/18/2013	0	0	0	0	0	0
8/19/2013	0	0	0	0	0	0
8/20/2013	0	0	0	0	0	0
8/21/2013	0	0	0	0	0	0
8/22/2013	0	0	0	0	0	0

AV: Ice Avalanche

DF: Icy Debris Flow

RF: Rockfall

SF: Slushflow

	Fan 3 Events at Douglas Glacier					
Date	**AV**	**DF**	**RF**	**SF**	**Tot**	**Ar3**
1/7/2013	0	0	0	0	0	0
1/8/2013	0	0	0	0	0	0
1/9/2013	0	0	0	0	0	0
1/10/2013	0	0	0	0	0	0
1/11/2013	0	0	0	0	0	0
1/12/2013	1	0	0	0	1	45
1/13/2013	0	0	0	0	0	0
1/14/2013	2	0	0	0	2	70
1/15/2013	0	0	0	0	0	0
1/16/2013	0	0	0	0	0	0
1/17/2013	3	0	0	0	3	8
1/18/2013	0	0	0	0	0	0
1/19/2013	0	0	0	0	0	0
1/20/2013	1	0	0	0	1	4
1/21/2013	0	0	0	0	0	0
1/22/2013	0	0	0	0	0	0
1/23/2013	0	0	0	0	0	0
1/24/2013	0	0	0	0	0	0
1/25/2013	0	0	0	0	0	0
1/26/2013	2	0	0	0	2	29
1/27/2013	0	0	0	0	0	0
1/28/2013	1	0	0	0	1	25
1/29/2013	0	0	0	0	0	0
1/30/2013	0	0	0	0	0	0
1/31/2013	0	0	0	0	0	0
2/1/2013	1	0	0	0	1	18
2/2/2013	0	0	0	0	0	0
2/3/2013	0	0	0	0	0	0
2/4/2013	1	0	0	0	1	23
2/5/2013	0	0	0	0	0	0
2/6/2013	0	0	0	0	0	0
2/7/2013	0	0	0	0	0	0
2/8/2013	0	0	0	0	0	0
2/9/2013	0	0	0	0	0	0

2/10/2013	0	0	0	0	0	0
2/11/2013	0	0	0	0	0	0
2/12/3013	1	0	0	0	1	5
2/13/2013	3	0	0	0	3	13
2/14/2013	0	0	0	0	0	0
2/15/2013	1	0	0	0	1	1
2/16/2013	1	0	0	0	1	8
2/17/2013	0	0	0	0	0	0
2/18/2013	0	0	0	0	0	0
2/19/2013	1	0	0	0	1	5
2/20/2013	0	0	0	0	0	0
2/21/2013	1	0	0	0	1	5
2/22/2013	4	0	0	0	4	13
2/23/2013	3	0	0	0	3	23
2/24/2013	0	0	0	0	0	0
2/25/2013	0	0	0	0	0	0
2/26/2013	2	0	0	0	2	14
2/27/2013	0	0	0	0	0	0
2/28/2013	0	0	0	0	0	0
3/1/2013	0	0	0	0	0	0
3/2/2013	3	0	0	0	3	23
3/3/2013	0	0	0	0	0	0
3/4/2013	0	0	0	0	0	0
3/5/2013	0	0	0	0	0	0
3/6/2013	0	0	0	0	0	0
3/7/2013	2	0	0	0	2	5
3/8/2013	3	0	0	0	3	15
3/9/2013	0	0	0	0	0	0
3/10/2013	0	0	0	0	0	0
3/11/2013	0	0	0	0	0	0
3/12/2013	0	0	0	0	0	0
3/13/2013	2	0	0	0	2	5
3/14/2013	0	0	0	0	0	0
3/15/2013	0	0	0	0	0	0
3/16/2013	2	0	0	0	2	8
3/17/2013	4	0	0	0	4	33
3/18/2013	0	0	0	0	0	0
3/19/2013	0	0	0	0	0	0
3/20/2013	0	0	0	0	0	0
3/21/2013	1	0	0	0	1	3
3/22/2013	4	0	0	0	4	37

3/23/2013	2	0	0	0	2	8
3/24/2013	2	0	0	0	2	18
3/25/3013	1	0	0	0	1	5
3/26/2013	0	0	0	0	0	0
3/27/2013	0	0	0	0	0	0
3/28/2013	3	0	0	0	3	23
3/29/2013	0	0	0	0	0	0
3/30/2013	4	0	0	0	4	29
3/31/2013	0	0	0	0	0	0
4/1/2013	2	0	0	0	2	11
4/2/2013	1	0	0	0	1	10
4/3/2013	1	0	0	0	1	8
4/4/2013	0	0	0	0	0	0
4/5/2013	0	0	0	0	0	0
4/6/2013	0	0	0	0	0	0
4/7/2013	5	0	0	0	5	24
4/8/2013	0	0	0	0	0	0
4/9/2013	0	0	0	0	0	0
4/10/2013	0	0	0	0	0	0
4/11/2013	1	0	0	0	1	3
4/12/2013	0	0	0	0	0	0
4/13/2013	0	0	0	0	0	0
4/14/2013	4	0	0	0	4	24
4/15/2013	0	0	0	0	0	0
4/16/2013	0	0	0	0	0	0
4/17/2013	0	0	0	0	0	0
4/18/2013	2	0	0	0	2	16
4/19/2013	0	0	0	0	0	0
4/20/2013	0	0	0	0	0	0
4/21/2013	0	0	0	0	0	0
4/22/2013	1	0	0	0	1	1
4/23/2013	6	0	0	0	6	39
4/24/2013	0	0	0	0	0	0
4/25/2013	0	0	0	0	0	0
4/26/2013	0	0	0	0	0	0
4/27/2013	0	0	0	0	0	0
4/28/2013	0	0	0	0	0	0
4/29/2014	4	0	0	0	4	27
4/30/2014	0	0	0	0	0	0
5/1/2013	0	0	0	0	0	0
5/2/2013	0	0	0	0	0	0

5/3/2013	0	0	0	0	0	0
5/4/2013	0	0	0	0	0	0
5/5/2013	0	0	0	0	0	0
5/6/2013	0	0	0	0	0	0
5/7/2013	1	0	0	0	1	6
5/8/2013	0	0	0	0	0	0
5/9/2013	0	0	0	0	0	0
5/10/2013	0	0	0	0	0	0
5/11/2013	0	0	0	0	0	0
5/12/2013	0	0	0	0	0	0
5/13/2013	0	0	0	0	0	0
5/14/2013	0	0	0	0	0	0
5/15/2013	0	0	0	0	0	0
5/16/2013	0	0	0	0	0	0
5/17/2013	0	0	0	0	0	0
5/18/2013	4	0	0	0	4	44
5/19/2013	0	0	0	0	0	0
5/20/2013	0	0	0	0	0	0
5/21/2013	1	0	0	0	1	5
5/22/2013	2	0	0	0	2	40
5/23/2013	0	0	1	0	1	100
5/24/2013	0	0	1	0	1	100
5/25/2013	0	0	0	0	0	0
5/26/2013	0	0	0	0	0	0
5/27/2013	0	0	0	0	0	0
5/28/2013	0	0	0	0	0	0
5/29/2013	0	0	0	0	0	0
5/30/2013	0	0	0	0	0	0
5/31/2013	0	0	0	0	0	0
6/1/2013	0	0	0	0	0	0
6/2/2013	0	0	0	0	0	0
6/3/2013	0	0	0	0	0	0
6/4/2013	0	0	0	0	0	0
6/5/2013	2	0	0	0	2	12
6/6/2013	5	0	0	0	5	21
6/7/2013	2	0	0	0	2	11
6/8/2013	1	0	0	0	1	10
6/9/2013	0	0	0	0	0	0
6/10/2013	0	0	0	0	0	0
6/11/2013	1	0	0	0	1	5
6/12/2013	0	0	0	0	0	0

6/13/2013	1	0	0	0	1	5
6/14/2013	1	0	0	0	1	12
6/15/2013	0	0	0	0	0	0
6/16/2013	0	0	0	0	0	0
6/17/2013	4	0	0	0	4	25
6/18/2013	0	0	0	0	0	0
6/19/2013	0	0	0	0	0	0
6/20/2013	0	0	0	0	0	0
6/21/2013	1	0	0	0	1	15
6/22/2013	0	0	0	0	0	0
6/23/2013	0	0	0	0	0	0
6/24/2013	1	0	0	0	1	15
6/25/2013	0	0	0	0	0	0
6/26/2013	0	0	0	1	1	5
6/27/2013	0	0	0	0	0	0
6/28/2013	1	0	0	0	1	10
6/29/2013	1	0	0	0	1	15
6/30/2013	0	0	0	0	0	0
7/1/2013	0	0	0	0	0	0
7/2/2013	0	0	0	0	0	0
7/3/2013	0	0	0	0	0	0
7/4/2013	1	0	0	0	1	10
7/5/2014	0	0	0	0	0	0
7/6/2013	0	0	0	0	0	0
7/7/2013	0	0	0	0	0	0
7/8/2013	0	0	0	3	3	50
7/9/2013	0	0	0	0	0	0
7/10/2013	0	0	0	0	0	0
7/11/2013	0	0	0	0	0	0
7/12/2013	0	0	0	0	0	0
7/13/2013	0	0	0	0	0	0
7/14/2013	0	0	0	0	0	0
7/15/2013	0	0	0	0	0	0
7/16/2013	0	0	0	0	0	0
7/17/2013	0	0	0	0	0	0
7/18/2013	0	0	0	0	0	0
7/19/2013	0	0	0	3	3	25
7/20/2013	0	0	0	0	0	0
7/21/2013	0	0	0	0	0	0
7/22/2013	0	0	0	0	0	0
7/23/2013	1	0	0	0	1	45

7/24/2013	0	0	0	0	0	0
7/25/2013	3	0	0	0	3	65
7/26/2013	0	0	0	0	0	0
7/27/2013	0	0	0	0	0	0
7/28/2013	1	0	0	0	1	5
7/29/2013	0	0	0	0	0	0
7/30/2013	0	0	0	0	0	0
7/31/2013	0	0	0	0	0	0
8/1/2013	0	0	0	0	0	0
8/2/2013	0	0	0	0	0	0
8/3/2013	0	0	0	0	0	0
8/4/2013	3	0	0	0	3	23
8/5/2013	0	0	0	0	0	0
8/6/2013	0	0	0	0	0	0
8/7/2013	1	0	0	0	1	100
8/8/2013	0	0	0	0	0	0
8/9/2013	1	0	0	0	1	15
8/10/2013	4	0	0	0	4	44
8/11/2013	1	0	0	0	1	10
8/12/2013	1	0	0	0	1	90
8/13/2013	1	0	0	0	1	4
8/14/2013	0	0	0	0	0	0
8/15/2013	0	0	0	0	0	0
8/16/2013	0	0	0	0	0	0
8/17/2013	0	0	0	0	0	0
8/18/2013	1	0	0	0	1	5
8/19/2013	1	0	0	0	1	10
8/20/2013	1	0	0	0	1	90
8/21/2013	0	0	0	0	0	0
8/22/2013	0	0	0	0	0	0

AV: Ice Avalanche

DF: Icy Debris Flow

RF: Rockfall

SF: Slushflow

	Fan 4 Events at Douglas Glacier					
Date	**AV**	**DF**	**RF**	**SF**	**Tot**	**Ar4**
1/7/2013	0	0	0	0	0	0

1/8/2013	0	0	0	0	0	0
1/9/2013	4	0	0	0	4	59
1/10/2013	3	0	0	0	3	19
1/11/2013	0	0	0	0	0	0
1/12/2013	2	0	0	0	2	13
1/13/2013	0	0	0	0	0	0
1/14/2013	6	0	0	0	6	29
1/15/2013	0	0	0	0	0	0
1/16/2013	1	0	0	0	1	5
1/17/2013	0	0	0	0	0	0
1/18/2013	1	0	0	0	1	22
1/19/2013	0	0	0	0	0	0
1/20/2013	2	0	0	0	2	18
1/21/2013	0	0	0	0	0	0
1/22/2013	0	0	0	0	0	0
1/23/2013	1	0	0	0	1	18
1/24/2013	0	0	0	0	0	0
1/25/2013	0	0	0	0	0	0
1/26/2013	7	0	0	0	7	77
1/27/2013	0	0	0	0	0	0
1/28/2013	2	0	0	0	2	22
1/29/2013	1	0	0	0	1	6
1/30/2013	0	0	0	0	0	0
1/31/2013	0	0	0	0	0	0
2/1/2013	1	0	0	0	1	4
2/2/2013	0	0	0	0	0	0
2/3/2013	0	0	0	0	0	0
2/4/2013	3	0	0	0	3	26
2/5/2013	3	0	0	0	3	19
2/6/2013	12	0	0	0	12	86
2/7/2013	0	0	0	0	0	0
2/8/2013	0	0	0	0	0	0
2/9/2013	3	0	0	0	3	20
2/10/2013	3	0	0	0	3	35
2/11/2013	3	0	0	0	3	32
2/12/3013	0	0	0	0	0	0
2/13/2013	2	0	0	0	2	9
2/14/2013	1	0	0	0	1	5
2/15/2013	5	0	0	0	5	16
2/16/2013	4	0	0	0	4	10
2/17/2013	0	0	0	0	0	0

2/18/2013	1	0	0	0	1	6
2/19/2013	8	0	0	0	8	47
2/20/2013	5	0	0	0	5	40
2/21/2013	4	0	0	0	4	16
2/22/2013	4	0	0	0	4	28
2/23/2013	0	0	0	0	0	0
2/24/2013	4	0	0	0	4	19
2/25/2013	0	0	0	0	0	0
2/26/2013	1	0	0	0	1	5
2/27/2013	2	0	0	0	2	6
2/28/2013	6	0	0	0	6	52
3/1/2013	1	0	0	0	1	4
3/2/2013	0	0	0	0	0	0
3/3/2013	1	0	0	0	1	8
3/4/2013	1	0	0	0	1	5
3/5/2013	0	0	0	0	0	0
3/6/2013	2	0	1	0	3	13
3/7/2013	1	0	0	0	1	4
3/8/2013	0	0	0	0	0	0
3/9/2013	0	0	0	0	0	0
3/10/2013	5	0	0	0	5	35
3/11/2013	0	0	0	0	0	0
3/12/2013	5	0	0	0	5	42
3/13/2013	0	0	0	0	0	0
3/14/2013	2	0	0	0	2	14
3/15/2013	4	0	0	0	4	25
3/16/2013	1	0	0	0	1	4
3/17/2013	3	0	0	0	3	11
3/18/2013	1	0	0	0	1	3
3/19/2013	4	0	0	0	4	23
3/20/2013	0	0	0	0	0	0
3/21/2013	2	0	0	0	2	9
3/22/2013	5	0	0	0	5	28
3/23/2013	12	0	0	0	12	59
3/24/2013	1	0	0	0	1	3
3/25/3013	1	0	0	0	1	7
3/26/2013	0	0	0	0	0	0
3/27/2013	0	0	0	0	0	0
3/28/2013	0	0	0	0	0	0
3/29/2013	3	0	0	0	3	12
3/30/2013	1	0	0	0	1	6

3/31/2013	2	0	0	0	2	16
4/1/2013	6	0	0	0	6	29
4/2/2013	1	0	0	0	1	4
4/3/2013	0	0	0	0	0	0
4/4/2013	3	0	0	0	3	25
4/5/2013	1	0	0	0	1	10
4/6/2013	5	0	0	0	5	24
4/7/2013	3	0	0	0	3	13
4/8/2013	2	0	0	0	2	10
4/9/2013	7	0	0	0	7	77
4/10/2013	0	0	0	0	0	0
4/11/2013	0	0	0	0	0	0
4/12/2013	0	0	0	0	0	0
4/13/2013	0	0	0	0	0	0
4/14/2013	2	0	0	0	2	16
4/15/2013	0	0	0	0	0	0
4/16/2013	0	0	0	0	0	0
4/17/2013	2	0	0	0	2	17
4/18/2013	0	0	0	0	0	0
4/19/2013	2	0	0	0	2	9
4/20/2013	0	0	0	0	0	0
4/21/2013	1	0	0	0	1	6
4/22/2013	2	0	0	0	2	10
4/23/2013	0	0	0	0	0	0
4/24/2013	3	0	0	0	3	26
4/25/2013	0	0	0	0	0	0
4/26/2013	0	0	0	0	0	0
4/27/2013	0	0	0	0	0	0
4/28/2013	3	0	0	0	3	8
4/29/2014	7	0	0	0	7	31
4/30/2014	14	0	0	0	14	80
5/1/2013	1	0	0	0	1	2
5/2/2013	0	0	0	0	0	0
5/3/2013	1	0	0	0	1	3
5/4/2013	0	0	0	0	0	0
5/5/2013	3	0	0	0	3	31
5/6/2013	3	0	0	0	3	14
5/7/2013	1	0	0	0	1	10
5/8/2013	0	0	0	0	0	0
5/9/2013	0	0	0	0	0	0
5/10/2013	0	0	0	0	0	0

5/11/2013	1	0	0	0	1	5
5/12/2013	0	0	0	0	0	0
5/13/2013	1	0	0	0	1	5
5/14/2013	0	0	0	0	0	0
5/15/2013	0	0	0	0	0	0
5/16/2013	1	0	0	0	1	5
5/17/2013	8	0	0	0	8	49
5/18/2013	6	0	0	0	6	53
5/19/2013	1	0	0	0	1	5
5/20/2013	1	0	0	0	1	5
5/21/2013	1	0	0	0	1	3
5/22/2013	1	0	0	0	1	6
5/23/2013	0	0	0	0	0	0
5/24/2013	0	0	0	0	0	0
5/25/2013	0	0	0	0	0	0
5/26/2013	0	0	0	0	0	0
5/27/2013	0	0	0	0	0	0
5/28/2013	0	0	0	0	0	0
5/29/2013	0	0	0	0	0	0
5/30/2013	0	0	0	0	0	0
5/31/2013	0	0	0	0	0	0
6/1/2013	0	0	0	0	0	0
6/2/2013	0	0	0	0	0	0
6/3/2013	0	0	0	0	0	0
6/4/2013	8	0	0	0	8	90
6/5/2013	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0
6/7/2013	0	0	0	0	0	0
6/8/2013	0	0	0	0	0	0
6/9/2013	0	0	0	0	0	0
6/10/2013	1	0	0	0	1	10
6/11/2013	1	0	0	0	1	3
6/12/2013	0	0	0	0	0	0
6/13/2013	1	0	0	0	1	6
6/14/2013	6	0	0	0	6	33
6/15/2013	0	0	0	0	0	0
6/16/2013	0	0	0	0	0	0
6/17/2013	1	0	0	0	1	1
6/18/2013	0	0	0	0	0	0
6/19/2013	3	0	0	0	3	16
6/20/2013	0	0	0	0	0	0

6/21/2013	0	0	0	0	0	0
6/22/2013	0	0	0	0	0	0
6/23/2013	0	0	0	0	0	0
6/24/2013	0	0	0	0	0	0
6/25/2013	0	0	0	0	0	0
6/26/2013	0	0	0	0	0	0
6/27/2013	0	0	0	0	0	0
6/28/2013	0	0	0	0	0	0
6/29/2013	0	0	0	0	0	0
6/30/2013	0	0	0	0	0	0
7/1/2013	0	0	0	0	0	0
7/2/2013	0	0	0	0	0	0
7/3/2013	0	0	0	0	0	0
7/4/2013	0	0	0	0	0	0
7/5/2014	0	0	0	0	0	0
7/6/2013	0	0	0	0	0	0
7/7/2013	0	0	0	0	0	0
7/8/2013	0	0	0	0	0	0
7/9/2013	0	0	0	0	0	0
7/10/2013	0	0	0	0	0	0
7/11/2013	0	0	0	0	0	0
7/12/2013	0	0	0	0	0	0
7/13/2013	0	0	0	0	0	0
7/14/2013	0	0	0	0	0	0
7/15/2013	0	0	0	0	0	0
7/16/2013	0	0	0	0	0	0
7/17/2013	0	0	0	0	0	0
7/18/2013	0	0	0	0	0	0
7/19/2013	0	0	0	0	0	0
7/20/2013	0	0	0	0	0	0
7/21/2013	0	0	0	0	0	0
7/22/2013	0	0	0	0	0	0
7/23/2013	3	0	0	0	3	50
7/24/2013	0	0	0	0	0	0
7/25/2013	0	0	0	0	0	0
7/26/2013	0	0	0	0	0	0
7/27/2013	0	0	0	0	0	0
7/28/2013	0	0	0	0	0	0
7/29/2013	0	0	0	0	0	0
7/30/2013	1	0	0	0	1	10
7/31/2013	1	0	0	0	1	4

8/1/2013	0	0	0	0	0	0
8/2/2013	0	0	0	0	0	0
8/3/2013	0	0	0	0	0	0
8/4/2013	7	0	0	0	7	62
8/5/2013	0	0	0	0	0	0
8/6/2013	0	0	0	0	0	0
8/7/2013	6	0	0	0	6	100
8/8/2013	0	0	0	0	0	0
8/9/2013	0	0	0	0	0	0
8/10/2013	0	0	0	0	0	0
8/11/2013	2	0	0	0	2	22
8/12/2013	0	0	0	0	0	0
8/13/2013	0	0	0	0	0	0
8/14/2013	0	0	0	0	0	0
8/15/2013	0	0	0	0	0	0
8/16/2013	0	0	0	0	0	0
8/17/2013	0	0	0	0	0	0
8/18/2013	1	0	0	0	1	4
8/19/2013	0	0	0	0	0	0
8/20/2013	0	0	0	0	0	0
8/21/2013	0	0	0	0	0	0
8/22/2013	0	0	0	0	0	0

AV: Ice Avalanche

DF: Icy Debris Flow

RF: Rockfall

SF: Slushflow

	Fan 5 Events at Douglas Glacier					
Date	**AV**	**DF**	**RF**	**SF**	**Tot**	**AR5**
1/7/2013	0	0	0	0	0	0
1/8/2013	0	0	0	0	0	0
1/9/2013	0	0	0	0	0	0
1/10/2013	1	0	0	0	1	2
1/11/2013	0	0	0	0	0	0
1/12/2013	2	0	0	0	2	8
1/13/2013	0	0	0	0	0	0

1/14/2013	3	0	0	0	3	9
1/15/2013	0	0	0	0	0	0
1/16/2013	0	0	0	0	0	0
1/17/2013	0	0	0	0	0	0
1/18/2013	0	0	0	0	0	0
1/19/2013	0	0	0	0	0	0
1/20/2013	1	0	0	0	1	60
1/21/2013	0	0	0	0	0	0
1/22/2013	0	0	0	0	0	0
1/23/2013	0	0	0	0	0	0
1/24/2013	3	0	0	0	3	32
1/25/2013	2	0	0	0	2	20
1/26/2013	0	0	0	0	0	0
1/27/2013	0	0	0	0	0	0
1/28/2013	0	0	0	0	0	0
1/29/2013	1	0	0	0	1	5
1/30/2013	0	0	0	0	0	0
1/31/2013	0	0	0	0	0	0
2/1/2013	0	0	0	0	0	0
2/2/2013	0	0	0	0	0	0
2/3/2013	0	0	0	0	0	0
2/4/2013	0	0	0	0	0	0
2/5/2013	1	0	0	0	1	70
2/6/2013	0	0	0	0	0	0
2/7/2013	0	0	0	0	0	0
2/8/2013	0	0	0	0	0	0
2/9/2013	2	0	0	0	2	8
2/10/2013	0	0	0	0	0	0
2/11/2013	0	0	0	0	0	0
2/12/3013	1	0	0	0	1	4
2/13/2013	0	0	0	0	0	0
2/14/2013	0	0	0	0	0	0
2/15/2013	0	0	0	0	0	0
2/16/2013	1	0	0	0	1	4
2/17/2013	0	0	0	0	0	0
2/18/2013	0	0	0	0	0	0
2/19/2013	3	0	0	0	3	68
2/20/2013	1	0	0	0	1	10
2/21/2013	1	0	0	0	1	10
2/22/2013	0	0	0	0	0	0
2/23/2013	2	0	0	0	2	15

2/24/2013	1	0	0	0	1	2
2/25/2013	1	0	0	0	1	16
2/26/2013	0	0	0	0	0	0
2/27/2013	0	0	0	0	0	0
2/28/2013	2	0	0	0	2	13
3/1/2013	0	0	0	0	0	0
3/2/2013	2	0	0	0	2	20
3/3/2013	0	0	0	0	0	0
3/4/2013	0	0	0	0	0	0
3/5/2013	2	0	0	0	2	23
3/6/2013	2	0	0	0	2	14
3/7/2013	2	0	0	0	2	14
3/8/2013	0	0	0	0	0	0
3/9/2013	2	0	0	0	2	80
3/10/2013	2	0	0	0	2	12
3/11/2013	1	0	0	0	1	1
3/12/2013	2	0	0	0	2	87
3/13/2013	1	0	0	0	1	7
3/14/2013	0	0	0	0	0	0
3/15/2013	0	0	0	0	0	0
3/16/2013	1	0	0	0	1	5
3/17/2013	0	0	0	0	0	0
3/18/2013	0	0	0	0	0	0
3/19/2013	1	0	0	0	1	7
3/20/2013	0	0	0	0	0	0
3/21/2013	0	0	0	0	0	0
3/22/2013	1	0	0	0	1	3
3/23/2013	3	0	0	0	3	26
3/24/2013	0	0	0	0	0	0
3/25/3013	0	0	0	0	0	0
3/26/2013	2	0	0	0	2	8
3/27/2013	0	0	0	0	0	0
3/28/2013	0	0	0	0	0	0
3/29/2013	0	0	0	0	0	0
3/30/2013	0	0	0	0	0	0
3/31/2013	0	0	0	0	0	0
4/1/2013	0	0	0	0	0	0
4/2/2013	0	0	0	0	0	0
4/3/2013	1	0	0	0	1	5
4/4/2013	0	0	0	0	0	0
4/5/2013	0	0	0	0	0	0

4/6/2013	0	0	0	0	0	0
4/7/2013	0	0	0	0	0	0
4/8/2013	1	0	0	0	1	3
4/9/2013	1	0	0	0	1	5
4/10/2013	0	0	0	0	0	0
4/11/2013	0	0	0	0	0	0
4/12/2013	0	0	0	0	0	0
4/13/2013	0	0	0	0	0	0
4/14/2013	0	0	0	0	0	0
4/15/2013	0	0	0	0	0	0
4/16/2013	1	0	0	0	1	10
4/17/2013	1	0	0	0	1	4
4/18/2013	0	0	0	0	0	0
4/19/2013	0	0	0	0	0	0
4/20/2013	0	0	0	0	0	0
4/21/2013	0	0	0	0	0	0
4/22/2013	0	0	0	0	0	0
4/23/2013	0	0	0	0	0	0
4/24/2013	0	0	0	0	0	0
4/25/2013	0	0	0	0	0	0
4/26/2013	0	0	0	0	0	0
4/27/2013	1	0	0	0	1	4
4/28/2013	4	0	0	0	4	18
4/29/2014	0	0	0	0	0	0
4/30/2014	2	0	0	0	2	13
5/1/2013	0	0	0	0	0	0
5/2/2013	0	0	0	0	0	0
5/3/2013	2	0	0	0	2	11
5/4/2013	0	0	0	0	0	0
5/5/2013	2	0	0	0	2	10
5/6/2013	2	0	0	0	2	7
5/7/2013	0	0	0	0	0	0
5/8/2013	0	0	0	0	0	0
5/9/2013	1	0	0	0	1	20
5/10/2013	0	0	0	0	0	0
5/11/2013	0	0	0	0	0	0
5/12/2013	0	0	0	0	0	0
5/13/2013	0	0	0	0	0	0
5/14/2013	2	0	0	0	2	15
5/15/2013	1	0	0	0	1	2
5/16/2013	0	0	0	0	0	0

5/17/2013	0	0	0	0	0	0
5/18/2013	2	0	0	0	2	12
5/19/2013	2	0	0	0	2	11
5/20/2013	0	0	0	0	0	0
5/21/2013	3	0	0	0	3	43
5/22/2013	0	0	0	0	0	0
5/23/2013	0	0	0	0	0	0
5/24/2013	0	0	0	0	0	0
5/25/2013	0	0	0	0	0	0
5/26/2013	0	0	0	0	0	0
5/27/2013	0	0	0	0	0	0
5/28/2013	0	0	0	0	0	0
5/29/2013	0	0	0	0	0	0
5/30/2013	0	0	0	0	0	0
5/31/2013	0	0	0	0	0	0
6/1/2013	0	0	0	0	0	0
6/2/2013	0	0	0	0	0	0
6/3/2013	0	0	0	0	0	0
6/4/2013	4	0	0	0	4	37
6/5/2013	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0
6/7/2013	0	0	0	0	0	0
6/8/2013	0	0	0	0	0	0
6/9/2013	0	0	0	0	0	0
6/10/2013	0	0	0	0	0	0
6/11/2013	0	0	0	0	0	0
6/12/2013	0	0	0	0	0	0
6/13/2013	0	0	0	0	0	0
6/14/2013	0	0	0	0	0	0
6/15/2013	0	0	0	0	0	0
6/16/2013	0	0	0	0	0	0
6/17/2013	0	0	0	0	0	0
6/18/2013	0	0	0	0	0	0
6/19/2013	0	0	0	0	0	0
6/20/2013	0	0	0	0	0	0
6/21/2013	0	0	0	0	0	0
6/22/2013	0	0	0	0	0	0
6/23/2013	0	0	0	0	0	0
6/24/2013	0	0	0	0	0	0
6/25/2013	0	0	0	0	0	0
6/26/2013	0	0	0	0	0	0

6/27/2013	0	0	0	0	0	0
6/28/2013	0	0	0	0	0	0
6/29/2013	0	0	0	0	0	0
6/30/2013	0	0	0	0	0	0
7/1/2013	0	0	0	0	0	0
7/2/2013	0	0	0	0	0	0
7/3/2013	0	0	0	0	0	0
7/4/2013	0	0	0	0	0	0
7/5/2014	0	0	0	0	0	0
7/6/2013	0	0	0	0	0	0
7/7/2013	0	0	0	0	0	0
7/8/2013	0	0	0	0	0	0
7/9/2013	0	0	0	0	0	0
7/10/2013	0	0	0	0	0	0
7/11/2013	0	0	0	0	0	0
7/12/2013	0	0	0	0	0	0
7/13/2013	0	0	0	0	0	0
7/14/2013	0	0	0	0	0	0
7/15/2013	0	0	0	0	0	0
7/16/2013	0	0	0	0	0	0
7/17/2013	0	0	0	0	0	0
7/18/2013	0	0	0	0	0	0
7/19/2013	0	0	0	0	0	0
7/20/2013	0	0	0	0	0	0
7/21/2013	0	0	0	0	0	0
7/22/2013	0	0	0	0	0	0
7/23/2013	0	0	0	0	0	0
7/24/2013	0	0	0	0	0	0
7/25/2013	0	0	0	0	0	0
7/26/2013	0	0	0	0	0	0
7/27/2013	0	0	0	0	0	0
7/28/2013	0	0	0	0	0	0
7/29/2013	0	0	0	0	0	0
7/30/2013	0	0	0	0	0	0
7/31/2013	0	0	0	0	0	0
8/1/2013	0	0	0	0	0	0
8/2/2013	0	0	0	0	0	0
8/3/2013	0	0	0	0	0	0
8/4/2013	0	0	0	0	0	0
8/5/2013	0	0	0	0	0	0
8/6/2013	0	0	0	0	0	0

8/7/2013	0	0	0	0	0	0
8/8/2013	0	0	0	0	0	0
8/9/2013	0	0	0	0	0	0
8/10/2013	0	0	0	0	0	0
8/11/2013	0	0	0	0	0	0
8/12/2013	0	0	0	0	0	0
8/13/2013	0	0	0	0	0	0
8/14/2013	0	0	0	0	0	0
8/15/2013	0	0	0	0	0	0
8/16/2013	0	0	0	0	0	0
8/17/2013	0	0	0	0	0	0
8/18/2013	0	0	0	0	0	0
8/19/2013	0	0	0	0	0	0
8/20/2013	0	0	0	0	0	0
8/21/2013	0	0	0	0	0	0
8/22/2013	0	0	0	0	0	0

AV: Ice Avalanche

DF: Icy Debris Flow

RF: Rockfall

SF: Slushflow

	Mount Sefton Events at Douglas Glacier					
Date	**AV**	**DF**	**RF**	**SF**	**RF/AV**	**Tot**
1/7/2013	0	0	0	0	0	0
1/8/2013	0	0	0	0	0	0
1/9/2013	0	0	0	0	0	0
1/10/2013	0	0	0	0	0	0
1/11/2013	0	0	0	0	0	0
1/12/2013	0	0	0	0	0	0
1/13/2013	0	0	0	0	0	0
1/14/2013	0	0	0	0	0	0
1/15/2013	0	0	0	0	0	0
1/16/2013	0	0	0	0	0	0
1/17/2013	0	0	0	0	0	0
1/18/2013	0	0	0	0	0	0
1/19/2013	0	0	0	0	0	0
1/20/2013	1	0	0	0	0	1
1/21/2013	0	0	0	0	0	0

1/22/2013	0	0	0	0	0	0
1/23/2013	0	0	0	0	0	0
1/24/2013	0	0	0	0	0	0
1/25/2013	0	0	0	0	0	0
1/26/2013	0	0	0	0	0	0
1/27/2013	0	0	0	0	0	0
1/28/2013	0	0	0	0	0	0
1/29/2013	0	0	0	0	0	0
1/30/2013	0	0	0	0	0	0
1/31/2013	0	0	0	0	0	0
2/1/2013	0	0	0	0	0	0
2/2/2013	0	0	0	0	0	0
2/3/2013	0	0	0	0	0	0
2/4/2013	0	0	0	0	0	0
2/5/2013	0	0	0	0	0	0
2/6/2013	0	0	0	0	0	0
2/7/2013	0	0	0	0	0	0
2/8/2013	0	0	0	0	0	0
2/9/2013	0	0	0	0	0	0
2/10/2013	0	0	0	0	0	0
2/11/2013	0	0	0	0	0	0
2/12/3013	0	0	0	0	0	0
2/13/2013	0	0	0	0	0	0
2/14/2013	0	0	0	0	0	0
2/15/2013	0	0	0	0	0	0
2/16/2013	1	0	0	0	0	1
2/17/2013	0	0	0	0	0	0
2/18/2013	0	0	0	0	0	0
2/19/2013	0	0	0	0	0	0
2/20/2013	0	0	0	0	0	0
2/21/2013	0	0	0	0	0	0
2/22/2013	1	0	0	0	0	1
2/23/2013	0	0	0	0	0	0
2/24/2013	0	0	0	0	0	0
2/25/2013	0	0	0	0	0	0
2/26/2013	0	0	0	0	0	0
2/27/2013	0	0	0	0	0	0
2/28/2013	0	0	0	0	0	0
3/1/2013	0	0	0	0	0	0
3/2/2013	0	0	0	0	0	0
3/3/2013	0	0	0	0	0	0

3/4/2013	0	0	0	0	0	0
3/5/2013	1	0	0	0	0	1
3/6/2013	0	0	0	0	0	0
3/7/2013	0	0	0	0	0	0
3/8/2013	0	0	0	0	0	0
3/9/2013	0	0	0	0	0	0
3/10/2013	0	0	0	0	0	0
3/11/2013	0	0	0	0		0
3/12/2013	0	0	0	0	0	0
3/13/2013	1	0	0	0	0	1
3/14/2013	0	0	0	0	0	0
3/15/2013	0	0	0	0	0	0
3/16/2013	0	0	0	0	0	0
3/17/2013	0	0	0	0	0	0
3/18/2013	0	0	0	0	0	0
3/19/2013	0	0	0	0	0	0
3/20/2013	0	0	0	0	0	0
3/21/2013	0	0	0	0	0	0
3/22/2013	0	0	0	0	0	0
3/23/2013	0	0	0	0	0	0
3/24/2013	0	0	0	0	0	0
3/25/3013	0	0	0	0	0	0
3/26/2013	0	0	0	0	0	0
3/27/2013	0	0	0	0	0	0
3/28/2013	0	0	0	0	0	0
3/29/2013	0	0	0	0	0	0
3/30/2013	0	0	0	0	0	0
3/31/2013	0	0	0	0	0	0
4/1/2013	0	0	0	0	0	0
4/2/2013	0	0	0	0	0	0
4/3/2013	0	0	0	0	0	0
4/4/2013	0	0	0	0	0	0
4/5/2013	0	0	0	0	0	0
4/6/2013	0	0	0	0	0	0
4/7/2013	2	0	0	0	0	2
4/8/2013	1	0	0	0	0	1
4/9/2013	0	0	0	0	0	0
4/10/2013	2	0	0	0	0	2
4/11/2013	0	0	0	0	0	0
4/12/2013	0	0	0	0	0	0
4/13/2013	0	0	0	0	0	0

4/14/2013	0	0	0	0	0	0
4/15/2013	0	0	0	0	0	0
4/16/2013	0	0	0	0	0	0
4/17/2013	0	0	0	0	0	0
4/18/2013	0	0	0	0	0	0
4/19/2013	0	0	0	0	0	0
4/20/2013	0	0	0	0	0	0
4/21/2013	0	0	0	0	0	0
4/22/2013	0	0	0	0	0	0
4/23/2013	0	0	0	0	0	0
4/24/2013	0	0	0	0	0	0
4/25/2013	0	0	0	0	0	0
4/26/2013	0	0	0	0	0	0
4/27/2013	0	0	0	0	0	0
4/28/2013	0	0	0	0	0	0
4/29/2014	0	0	0	0	0	0
4/30/2014	0	0	0	0	0	0
5/1/2013	0	0	0	0	0	0
5/2/2013	0	0	0	0	0	0
5/3/2013	0	0	0	0	0	0
5/4/2013	0	0	0	0	0	0
5/5/2013	2	0	0	0	0	2
5/6/2013	0	0	0	0	0	0
5/7/2013	0	0	0	0	0	0
5/8/2013	0	0	0	0	0	0
5/9/2013	0	0	0	0	0	0
5/10/2013	0	0	0	0	0	0
5/11/2013	0	0	0	0	0	0
5/12/2013	0	0	0	0	0	0
5/13/2013	0	0	0	0	0	0
5/14/2013	0	0	0	0	0	0
5/15/2013	1	0	0	0	0	1
5/16/2013	0	0	0	0	0	0
5/17/2013	0	0	0	0	0	0
5/18/2013	0	0	0	0	0	0
5/19/2013	0	0	0	0	0	0
5/20/2013	0	0	0	0	0	0
5/21/2013	0	0	0	0	0	0
5/22/2013	0	0	0	0	0	0
5/23/2013	0	0	0	0	0	0
5/24/2013	0	0	0	0	0	0

5/25/2013	0	0	0	0	0	0
5/26/2013	0	0	0	0	0	0
5/27/2013	0	0	0	0	0	0
5/28/2013	0	0	0	0	0	0
5/29/2013	0	0	0	0	0	0
5/30/2013	0	0	0	0	0	0
5/31/2013	0	0	0	0	0	0
6/1/2013	0	0	0	0	0	0
6/2/2013	0	0	0	0	0	0
6/3/2013	0	0	0	0	0	0
6/4/2013	0	0	0	0	0	0
6/5/2013	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0
6/7/2013	0	0	0	0	0	0
6/8/2013	0	0	0	0	0	0
6/9/2013	0	0	0	0	0	0
6/10/2013	0	0	0	0	0	0
6/11/2013	0	0	0	0	0	0
6/12/2013	0	0	0	0	0	0
6/13/2013	0	0	0	0	0	0
6/14/2013	0	0	0	0	0	0
6/15/2013	0	0	0	0	0	0
6/16/2013	0	0	0	0	0	0
6/17/2013	0	0	0	0	0	0
6/18/2013	0	0	0	0	0	0
6/19/2013	0	0	0	0	0	0
6/20/2013	0	0	0	0	0	0
6/21/2013	0	0	0	0	0	0
6/22/2013	0	0	0	0	0	0
6/23/2013	0	0	0	0	0	0
6/24/2013	0	0	0	0	0	0
6/25/2013	0	0	0	0	0	0
6/26/2013	0	0	0	0	0	0
6/27/2013	0	0	0	0	0	0
6/28/2013	0	0	0	0	0	0
6/29/2013	0	0	0	0	0	0
6/30/2013	0	0	0	0	0	0
7/1/2013	0	0	0	0	0	0
7/2/2013	0	0	0	0	0	0
7/3/2013	0	0	0	0	0	0
7/4/2013	0	0	0	0	0	0

7/5/2014	0	0	0	0	0	0
7/6/2013	0	0	0	0	0	0
7/7/2013	0	0	0	0	0	0
7/8/2013	0	0	0	0	0	0
7/9/2013	0	0	0	0	0	0
7/10/2013	0	0	0	0	0	0
7/11/2013	0	0	0	0	0	0
7/12/2013	0	0	0	0	0	0
7/13/2013	0	0	0	0	0	0
7/14/2013	0	0	0	0	0	0
7/15/2013	0	0	0	0	0	0
7/16/2013	0	0	0	0	0	0
7/17/2013	0	0	0	0	0	0
7/18/2013	0	0	0	0	0	0
7/19/2013	0	0	0	2	0	2
7/20/2013	0	0	0	0	0	0
7/21/2013	0	0	0	1	0	1
7/22/2013	0	0	0	0	0	0
7/23/2013	0	0	0	0	1	1
7/24/2013	0	0	0	0	0	0
7/25/2013	0	0	0	0	0	0
7/26/2013	0	0	0	0	0	0
7/27/2013	0	0	0	0	0	0
7/28/2013	0	0	0	0	0	0
7/29/2013	0	0	0	0	0	0
7/30/2013	0	0	0	0	0	0
7/31/2013	0	0	0	0	0	0
8/1/2013	0	0	0	0	0	0
8/2/2013	0	0	0	0	0	0
8/3/2013	0	0	0	0	0	0
8/4/2013	0	0	0	0	0	0
8/5/2013	0	0	0	0	0	0
8/6/2013	0	0	0	0	0	0
8/7/2013	0	0	0	0	1	1
8/8/2013	0	0	0	0	0	0
8/9/2013	0	0	0	0	0	0
8/10/2013	0	0	0	0	0	0
8/11/2013	0	0	0	0	0	0
8/12/2013	0	0	0	0	0	0
8/13/2013	0	0	0	0	0	0
8/14/2013	0	0	0	0	0	0

8/15/2013	0	0	0	0	0	0
8/16/2013	0	0	0	0	0	0
8/17/2013	0	0	0	0	0	0
8/18/2013	0	0	0	0	0	0
8/19/2013	0	0	0	0	0	0
8/20/2013	0	0	0	0	0	0
8/21/2013	0	0	0	0	0	0
8/22/2013	0	0	0	0	0	0

AV: Ice Avalanche

DF: Icy Debris Flow

RF: Rockfall

SF: Slushflow

	Mount Sefton Events at Douglas Glacier					
Date	AV	DF	RF	SF	RF/AV	Tot
1/7/2013	0	0	0	0	0	0
1/8/2013	0	0	0	0	0	0
1/9/2013	0	0	0	0	0	0
1/10/2013	0	0	0	0	0	0
1/11/2013	0	0	0	0	0	0
1/12/2013	0	0	0	0	0	0
1/13/2013	0	0	0	0	0	0
1/14/2013	0	0	0	0	0	0
1/15/2013	0	0	0	0	0	0
1/16/2013	0	0	0	0	0	0
1/17/2013	0	0	0	0	0	0
1/18/2013	0	0	0	0	0	0
1/19/2013	0	0	0	0	0	0
1/20/2013	1	0	0	0	0	1
1/21/2013	0	0	0	0	0	0
1/22/2013	0	0	0	0	0	0
1/23/2013	0	0	0	0	0	0
1/24/2013	0	0	0	0	0	0
1/25/2013	0	0	0	0	0	0
1/26/2013	0	0	0	0	0	0
1/27/2013	0	0	0	0	0	0
1/28/2013	0	0	0	0	0	0

1/29/2013	0	0	0	0	0	0
1/30/2013	0	0	0	0	0	0
1/31/2013	0	0	0	0	0	0
2/1/2013	0	0	0	0	0	0
2/2/2013	0	0	0	0	0	0
2/3/2013	0	0	0	0	0	0
2/4/2013	0	0	0	0	0	0
2/5/2013	0	0	0	0	0	0
2/6/2013	0	0	0	0	0	0
2/7/2013	0	0	0	0	0	0
2/8/2013	0	0	0	0	0	0
2/9/2013	0	0	0	0	0	0
2/10/2013	0	0	0	0	0	0
2/11/2013	0	0	0	0	0	0
2/12/3013	0	0	0	0	0	0
2/13/2013	0	0	0	0	0	0
2/14/2013	0	0	0	0	0	0
2/15/2013	0	0	0	0	0	0
2/16/2013	1	0	0	0	0	1
2/17/2013	0	0	0	0	0	0
2/18/2013	0	0	0	0	0	0
2/19/2013	0	0	0	0	0	0
2/20/2013	0	0	0	0	0	0
2/21/2013	0	0	0	0	0	0
2/22/2013	1	0	0	0	0	1
2/23/2013	0	0	0	0	0	0
2/24/2013	0	0	0	0	0	0
2/25/2013	0	0	0	0	0	0
2/26/2013	0	0	0	0	0	0
2/27/2013	0	0	0	0	0	0
2/28/2013	0	0	0	0	0	0
3/1/2013	0	0	0	0	0	0
3/2/2013	0	0	0	0	0	0
3/3/2013	0	0	0	0	0	0
3/4/2013	0	0	0	0	0	0
3/5/2013	1	0	0	0	0	1
3/6/2013	0	0	0	0	0	0
3/7/2013	0	0	0	0	0	0
3/8/2013	0	0	0	0	0	0
3/9/2013	0	0	0	0	0	0
3/10/2013	0	0	0	0	0	0

3/11/2013	0	0	0	0		0
3/12/2013	0	0	0	0	0	0
3/13/2013	1	0	0	0	0	1
3/14/2013	0	0	0	0	0	0
3/15/2013	0	0	0	0	0	0
3/16/2013	0	0	0	0	0	0
3/17/2013	0	0	0	0	0	0
3/18/2013	0	0	0	0	0	0
3/19/2013	0	0	0	0	0	0
3/20/2013	0	0	0	0	0	0
3/21/2013	0	0	0	0	0	0
3/22/2013	0	0	0	0	0	0
3/23/2013	0	0	0	0	0	0
3/24/2013	0	0	0	0	0	0
3/25/3013	0	0	0	0	0	0
3/26/2013	0	0	0	0	0	0
3/27/2013	0	0	0	0	0	0
3/28/2013	0	0	0	0	0	0
3/29/2013	0	0	0	0	0	0
3/30/2013	0	0	0	0	0	0
3/31/2013	0	0	0	0	0	0
4/1/2013	0	0	0	0	0	0
4/2/2013	0	0	0	0	0	0
4/3/2013	0	0	0	0	0	0
4/4/2013	0	0	0	0	0	0
4/5/2013	0	0	0	0	0	0
4/6/2013	0	0	0	0	0	0
4/7/2013	2	0	0	0	0	2
4/8/2013	1	0	0	0	0	1
4/9/2013	0	0	0	0	0	0
4/10/2013	2	0	0	0	0	2
4/11/2013	0	0	0	0	0	0
4/12/2013	0	0	0	0	0	0
4/13/2013	0	0	0	0	0	0
4/14/2013	0	0	0	0	0	0
4/15/2013	0	0	0	0	0	0
4/16/2013	0	0	0	0	0	0
4/17/2013	0	0	0	0	0	0
4/18/2013	0	0	0	0	0	0
4/19/2013	0	0	0	0	0	0
4/20/2013	0	0	0	0	0	0

4/21/2013	0	0	0	0	0	0
4/22/2013	0	0	0	0	0	0
4/23/2013	0	0	0	0	0	0
4/24/2013	0	0	0	0	0	0
4/25/2013	0	0	0	0	0	0
4/26/2013	0	0	0	0	0	0
4/27/2013	0	0	0	0	0	0
4/28/2013	0	0	0	0	0	0
4/29/2014	0	0	0	0	0	0
4/30/2014	0	0	0	0	0	0
5/1/2013	0	0	0	0	0	0
5/2/2013	0	0	0	0	0	0
5/3/2013	0	0	0	0	0	0
5/4/2013	0	0	0	0	0	0
5/5/2013	2	0	0	0	0	2
5/6/2013	0	0	0	0	0	0
5/7/2013	0	0	0	0	0	0
5/8/2013	0	0	0	0	0	0
5/9/2013	0	0	0	0	0	0
5/10/2013	0	0	0	0	0	0
5/11/2013	0	0	0	0	0	0
5/12/2013	0	0	0	0	0	0
5/13/2013	0	0	0	0	0	0
5/14/2013	0	0	0	0	0	0
5/15/2013	1	0	0	0	0	1
5/16/2013	0	0	0	0	0	0
5/17/2013	0	0	0	0	0	0
5/18/2013	0	0	0	0	0	0
5/19/2013	0	0	0	0	0	0
5/20/2013	0	0	0	0	0	0
5/21/2013	0	0	0	0	0	0
5/22/2013	0	0	0	0	0	0
5/23/2013	0	0	0	0	0	0
5/24/2013	0	0	0	0	0	0
5/25/2013	0	0	0	0	0	0
5/26/2013	0	0	0	0	0	0
5/27/2013	0	0	0	0	0	0
5/28/2013	0	0	0	0	0	0
5/29/2013	0	0	0	0	0	0
5/30/2013	0	0	0	0	0	0
5/31/2013	0	0	0	0	0	0

6/1/2013	0	0	0	0	0	0
6/2/2013	0	0	0	0	0	0
6/3/2013	0	0	0	0	0	0
6/4/2013	0	0	0	0	0	0
6/5/2013	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0
6/7/2013	0	0	0	0	0	0
6/8/2013	0	0	0	0	0	0
6/9/2013	0	0	0	0	0	0
6/10/2013	0	0	0	0	0	0
6/11/2013	0	0	0	0	0	0
6/12/2013	0	0	0	0	0	0
6/13/2013	0	0	0	0	0	0
6/14/2013	0	0	0	0	0	0
6/15/2013	0	0	0	0	0	0
6/16/2013	0	0	0	0	0	0
6/17/2013	0	0	0	0	0	0
6/18/2013	0	0	0	0	0	0
6/19/2013	0	0	0	0	0	0
6/20/2013	0	0	0	0	0	0
6/21/2013	0	0	0	0	0	0
6/22/2013	0	0	0	0	0	0
6/23/2013	0	0	0	0	0	0
6/24/2013	0	0	0	0	0	0
6/25/2013	0	0	0	0	0	0
6/26/2013	0	0	0	0	0	0
6/27/2013	0	0	0	0	0	0
6/28/2013	0	0	0	0	0	0
6/29/2013	0	0	0	0	0	0
6/30/2013	0	0	0	0	0	0
7/1/2013	0	0	0	0	0	0
7/2/2013	0	0	0	0	0	0
7/3/2013	0	0	0	0	0	0
7/4/2013	0	0	0	0	0	0
7/5/2014	0	0	0	0	0	0
7/6/2013	0	0	0	0	0	0
7/7/2013	0	0	0	0	0	0
7/8/2013	0	0	0	0	0	0
7/9/2013	0	0	0	0	0	0
7/10/2013	0	0	0	0	0	0
7/11/2013	0	0	0	0	0	0

7/12/2013	0	0	0	0	0	0
7/13/2013	0	0	0	0	0	0
7/14/2013	0	0	0	0	0	0
7/15/2013	0	0	0	0	0	0
7/16/2013	0	0	0	0	0	0
7/17/2013	0	0	0	0	0	0
7/18/2013	0	0	0	0	0	0
7/19/2013	0	0	0	2	0	2
7/20/2013	0	0	0	0	0	0
7/21/2013	0	0	0	1	0	1
7/22/2013	0	0	0	0	0	0
7/23/2013	0	0	0	0	1	1
7/24/2013	0	0	0	0	0	0
7/25/2013	0	0	0	0	0	0
7/26/2013	0	0	0	0	0	0
7/27/2013	0	0	0	0	0	0
7/28/2013	0	0	0	0	0	0
7/29/2013	0	0	0	0	0	0
7/30/2013	0	0	0	0	0	0
7/31/2013	0	0	0	0	0	0
8/1/2013	0	0	0	0	0	0
8/2/2013	0	0	0	0	0	0
8/3/2013	0	0	0	0	0	0
8/4/2013	0	0	0	0	0	0
8/5/2013	0	0	0	0	0	0
8/6/2013	0	0	0	0	0	0
8/7/2013	0	0	0	0	1	1
8/8/2013	0	0	0	0	0	0
8/9/2013	0	0	0	0	0	0
8/10/2013	0	0	0	0	0	0
8/11/2013	0	0	0	0	0	0
8/12/2013	0	0	0	0	0	0
8/13/2013	0	0	0	0	0	0
8/14/2013	0	0	0	0	0	0
8/15/2013	0	0	0	0	0	0
8/16/2013	0	0	0	0	0	0
8/17/2013	0	0	0	0	0	0
8/18/2013	0	0	0	0	0	0
8/19/2013	0	0	0	0	0	0
8/20/2013	0	0	0	0	0	0
8/21/2013	0	0	0	0	0	0

8/22/2013	0	0	0	0	0	0